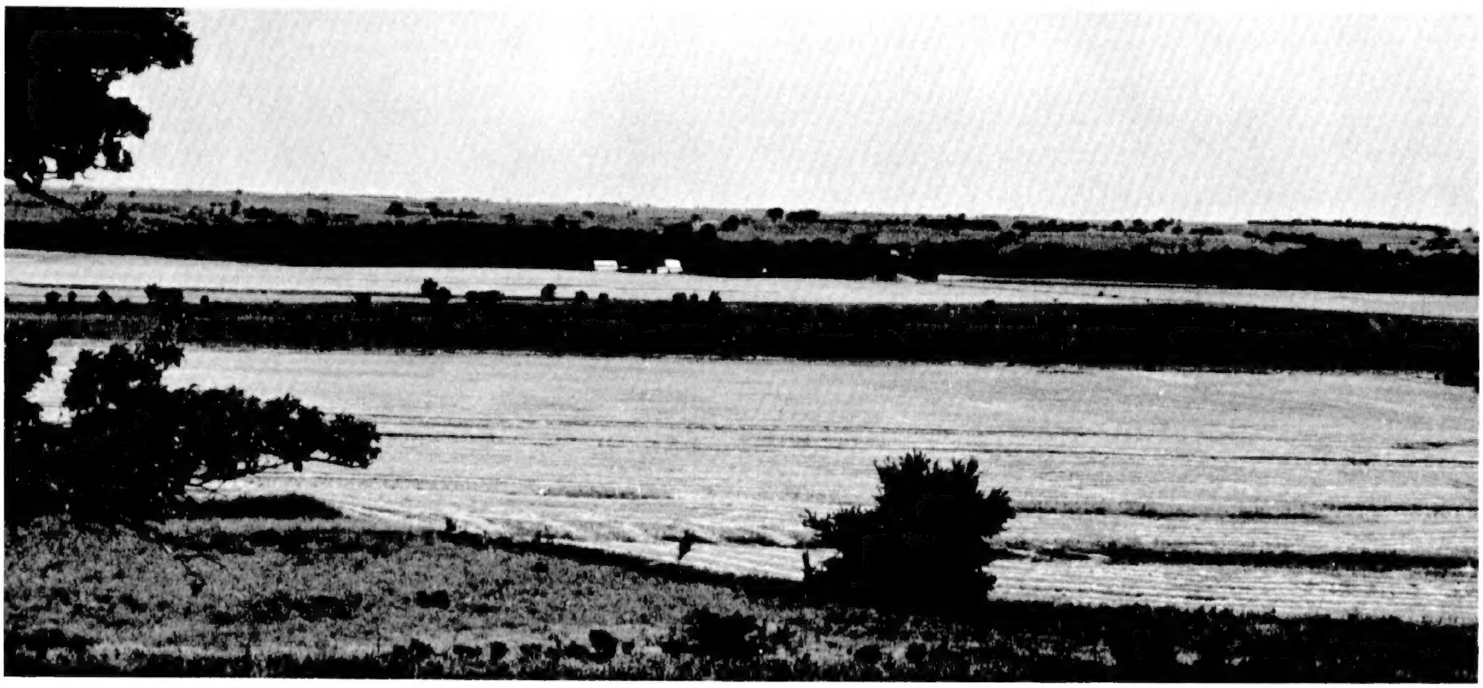
SOIL SURVEY OF

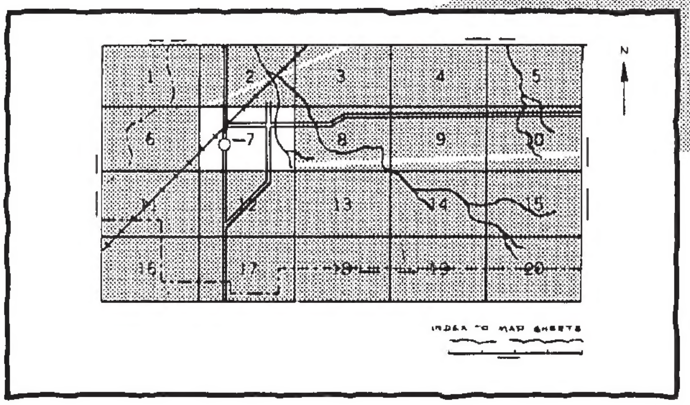
Cowley County, Kansas

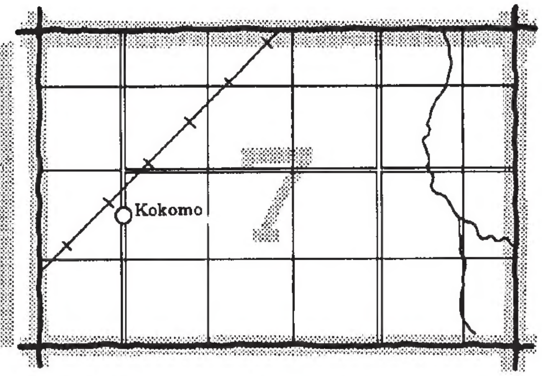


United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

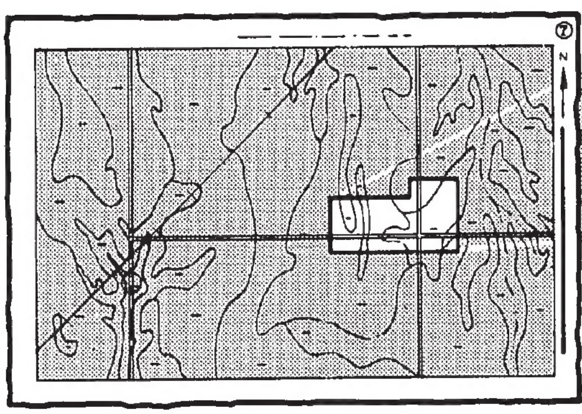
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

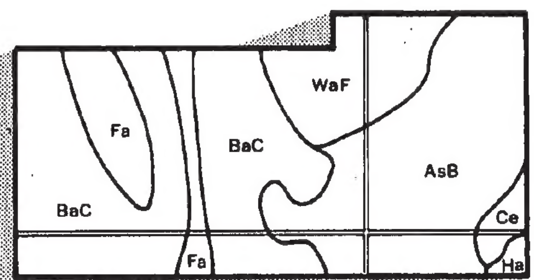




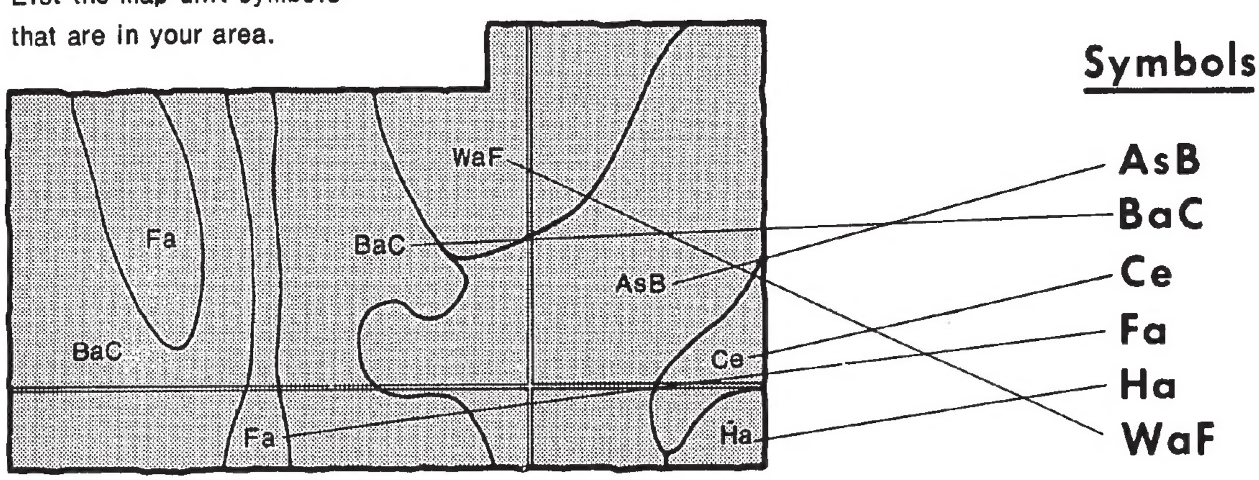
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



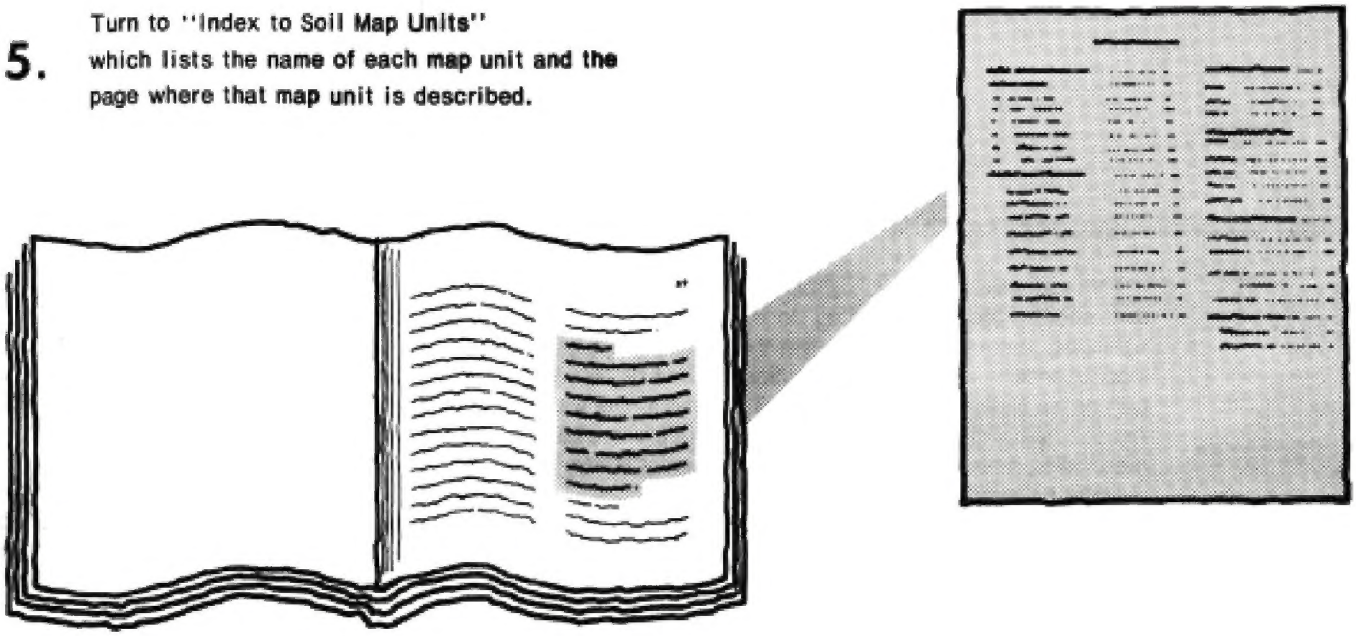


4. List the map unit symbols that are in your area.

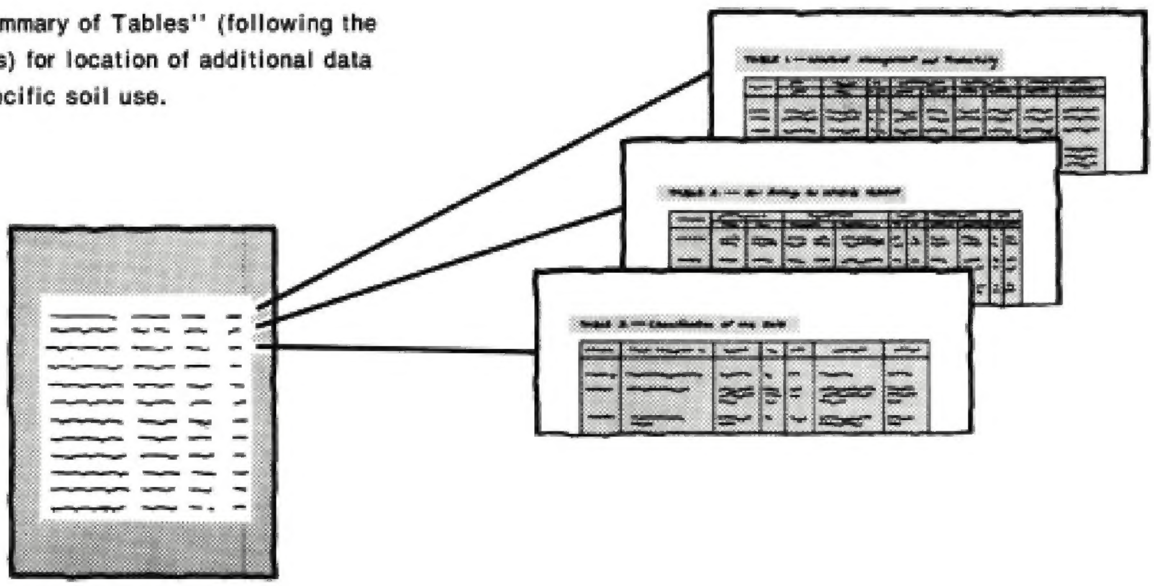


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1969-1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Cowley County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Reading and Brewer soils on bottom land are used for cultivated fields. Martin-Florence complex is on uplands in background.

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Issued January 1980

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Foreword

The Soil Survey of Cowley County, Kansas contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

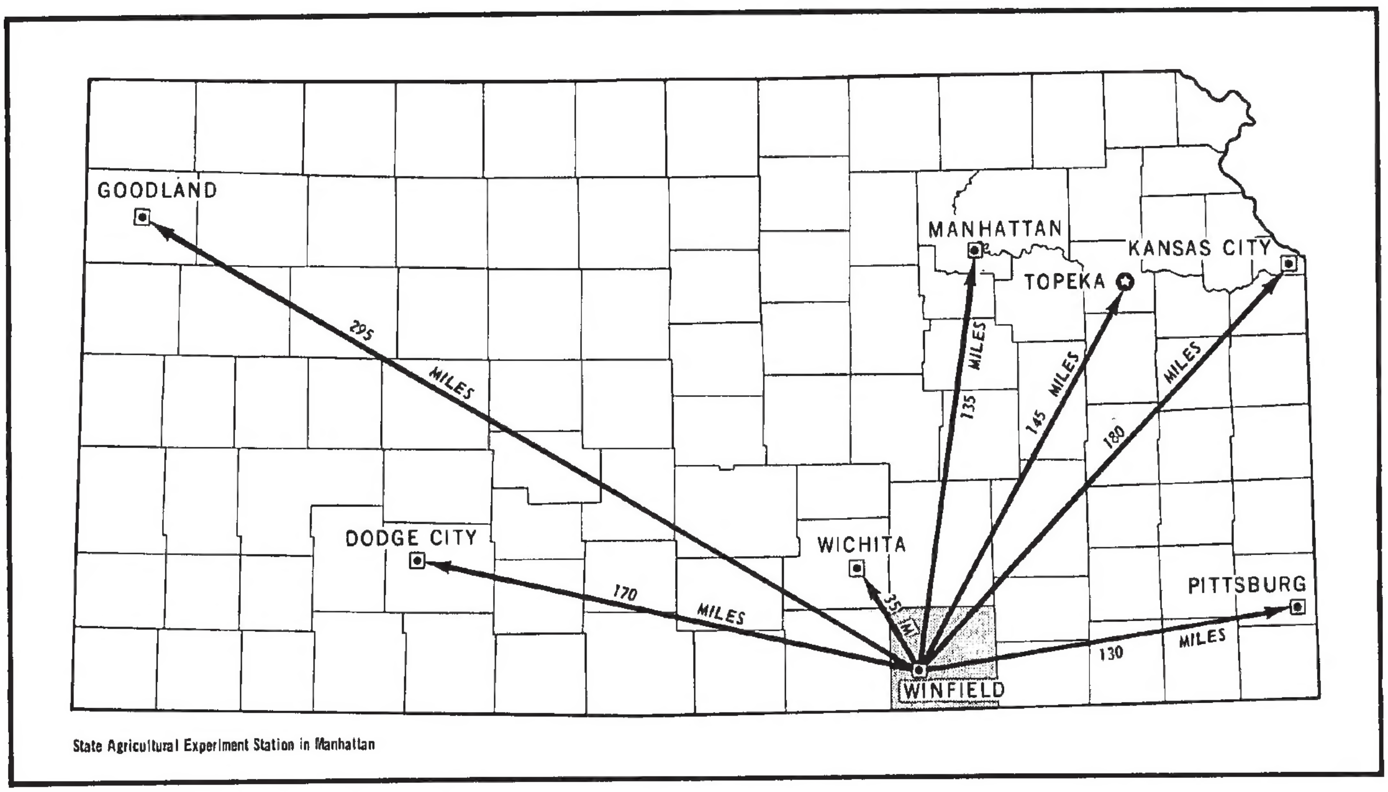
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service



Location of Cowley County in Kansas.

SOIL SURVEY OF COWLEY COUNTY, KANSAS

By Marcellus L. Horsch, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
in cooperation with the Kansas Agricultural Experiment Station

COWLEY COUNTY is on the southern border of Kansas adjacent to Oklahoma (see facing page). The county has a total acreage of 1,139 square miles, or 728,960 acres. The population of the county was 35,127 in 1976. In that year Winfield, the county seat, had a population of 10,362.

Cowley County was organized in 1870. The eastern three-fourths of Cowley County is in the Bluestem Hills land resource area, and most of the rest is in the Central Loess Plains resource area. The Bluestem Hills have deeply entrenched drainageways. The soils generally are deep or moderately deep and gently sloping to strongly sloping. They have clayey subsoils. In the Central Loess Plains the soils generally are deep, loamy, and nearly level to gently sloping. Elevation ranges from 900 to 1,500 feet above sea level.

Most of Cowley County is drained by four permanent flow streams: the Arkansas River, the Walnut River, Silver Creek, and Grouse Creek. These streams flow in a southerly direction.

Cowley County has a continental climate. Summers are hot, and winters are cold. Mean annual temperature is 46 to 70 degrees F. Annual precipitation ranges from 25 to 40 inches.

The main enterprises in the county are farming and ranching. Wheat and sorghum are the principal crops.

General nature of the county

Climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Cowley County is a typical continental type, as would be expected from its location in the interior of a large land mass in the middle latitudes. Such climates are characterized by large daily and annual variations in temperature. Winter is cold because of the frequent airflows from the polar regions; however, it only lasts from December through February. The warm temperature of summer lasts about six months every year. The transitional seasons of spring and fall are relatively short. The warm temperature provides a long growing season for crops in the county.

Cowley County is generally along the western edge of the moisture-laden air that flows northward from the Gulf of Mexico. Shifts in this current produce a rather wide range in the amount of precipitation received. Precipitation is heaviest from April through September. A large part of it falls during late evening, or night-time, thunderstorms. In dry years precipitation is marginal for agricultural production. Even in wet years, prolonged periods without rain often produce stress in growing crops.

Table 1 gives data on temperature and precipitation for Cowley County, as recorded at Winfield for the period 1941 to I970. Table 2 shows probable dates of the first freeze in fall and last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 36.6 degrees F, and the average daily minimum is 25.2 degrees F. The lowest temperature on record, -27 degreees F, occurred at Winfield on February I3, I905. In summer the average temperature is 79.2 degrees F, and the average daily maximum is 91.3 degrees F. The highest temperature was 118 degrees F, recorded on August 12, I936.

The annual precipitation is 32.85 inches. Of this, 23.67 inches, or 72 percent, usually falls during the period April through September, which includes the growing season for most crops. In 2 years out of 10, the April-September rainfall is less than 15.19 inches. The heaviest 1-day rainfall during the period of record was 7.60 inches at Winfield on July 12, I922.

Average snowfall is 10.4 inches. The greatest snowfall, 34.2 inches, occurred during the winter of 1948-49. In an average year, 15 days have at least 1 inch of snow on the ground, but it is unusual for the snow cover to last over 3 days in succession.

The prevailing wind is from the south. Average annual windspeed is 12 miles per hour; it is highest, 15 miles per hour, in March and April. An average of 70 percent of possible sunshine is received in summer, and 60 percent is received in winter.

Tornadoes and severe thunderstorms occur occasionally in Cowley County. These storms are usually so local in extent and short in duration that risk is small. Hail occurs during the warmer part of the year, but again it is infrequent and local. Crop damage by hail is less in this part of the State than it is further west.

Natural resources

Soil is the most important natural resource in the county. Livestock, which graze the rangeland, and crops produced on farms are marketable products that are affected by the soil.

Ground water is an important mineral resource of the county (*5*). Most of the water used for irrigation in the Arkansas and Walnut River valleys is ground water. Surface and ground water in the Walnut River basin may contain excessive amounts of chloride and sulfate salts (*3*). Winfield City Lake supplies water for several cities and rural water districts.

Other mineral resources of Cowley County are oil, gas, stone, and sand and gravel.

Oil and gas are important mineral resources in Cowley County.

Most of the structural stone presently quarried is from the Fort Riley Limestone unit, member of the Barnston Limestone. Two companies near Silverdale produce cut stone from quarries.

Sand and gravel are available from the alluvial deposits in the Walnut and Arkansas River valleys. Crushed aggregate can be produced in large quantities.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses

can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The eight general map units in Cowley County are discussed in the following pages. The names of some of these map units do not agree with those that appear in recently published surveys for adjacent counties. Differences are the result of refinements in the concepts of soil series and in the application of the soil classification system.

More detailed information about the individual soils in each map unit can be obtained by studying the detailed soil map and by reading about the soils in the section "Soil maps for detailed planning."

1. Irwin-Tabler-Rosehill

Deep and moderately deep, nearly level to moderately sloping, well drained soils that have a clayey subsoil; on uplands

This map unit makes up about 6 percent of the county. It is about 50 percent Irwin soils, 30 percent Tabler soils, 10 percent Rosehill soils, and 10 percent soils of minor extent.

The nearly level and gently sloping Irwin and Tabler soils are on broad ridgetops. Rosehill soils are on side slopes below the Irwin and Tabler soils. The deep, well drained Irwin soils have a silty clay loam surface layer, silty clay subsoil, and silty clay substratum. The deep, moderately well drained Tabler soils have a silty clay loam surface layer, silty clay subsoil, and silty clay substratum. The moderately deep, well drained Rosehill soils have a silty clay surface layer and subsoil, and a clay substratum. Shale is at depths of 20 to 40 inches.

The minor soils in this map unit are the somewhat excessively drained Sogn soils, the moderately well drained Clime and Verdigris soils, and the well drained Smolan soils. Clime and Sogn soils are on breaks near rock outcrops. Smolan soils are on side slopes, and Verdigris soils are in narrow drainageways.

These soils are used mainly for crops, but some small areas are rangeland or pasture. These soils are well suited to all dryland crops and grasses commonly grown in the county. Water erosion is a hazard on the gently and moderately sloping soils.

If adequately protected against erosion, these soils have good potential for cultivated crops. Potential of the soils also is good for rangeland. The potential of these soils for most engineering uses is poor because they are limited by high shrink-swell potential and low strength. The potential for openland wildlife habitat is fair to good.

2. Dale-Canadian-Lincoln

Deep, nearly level, well drained and somewhat excessively drained soils that have a silty or loamy subsoil or a sandy upper substratum; on stream terraces and flood plains

This map unit makes up about 4 percent of the county. It is about 30 percent Dale soils, 18 percent Canadian soils, 10 percent Lincoln soils, and 42 percent soils of minor extent (fig. 1).

Dale and Canadian soils are rarely flooded. They are on terraces and are slightly higher in elevation than the Lincoln soils. Lincoln soils are on flood plains that are occasionally flooded. Canadian and Dale soils are well drained, and Lincoln soils are somewhat excessively drained. Dale soils have a silt loam surface layer and subsoil, and a loam substratum. Canadian soils have a fine sandy loam surface layer, subsoil, and substratum. Lincoln soils have a fine sandy loam surface layer and loamy fine sand substratum.

The minor soils in this map unit are the Attica, Milan, Minco, Tivoli, and Lesho soils. Attica, Milan, and Minco soils are well drained. Tivoli soils are excessively drained, and Lesho soils are somewhat poorly drained. Attica and Tivoli soils are on small hills; Minco and Milan soils are on side slopes that are along the flood plains; and Lesho soils are in slightly depressional areas.

About 80 percent of the acreage is used for crops. The remainder is rangeland or pasture. These soils are well suited to all the crops and grasses commonly grown in the county. Wheat, sorghum, and alfalfa are the main crops, but the soils are well suited to truck farms or fruit orchards. Flooding is a hazard on the flood plain. Wind erosion is a hazard on the soils that have a moderately sandy or sandy surface layer.

If adequately protected against erosion and flooding, these soils have good potential for cultivated crops, truck farming, orchards, and rangeland. The potential of these soils for most engineering uses is fair to poor, because they are susceptible to flooding. The potential is fair to good for openland wildlife habitat.

3. Verdigris-Brewer-Norge

Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a silty or clayey subsoil; on stream terraces, flood plains, and adjacent uplands

This map unit makes up about 9 percent of the county. It is about 45 percent Verdigris soils, 18 percent Brewer soils, 15 percent Norge soils, and 22 percent soils of minor extent (fig. 2).

Verdigris soils are on low terraces and flood plains that are occasionally flooded. Brewer soils are on higher

terraces that are rarely flooded. The sloping Norge soils are on side slopes of adjacent uplands. The moderately well drained Verdigris soils have a silt loam surface layer and subsurface layer and a silty clay loam substratum. Brewer soils are moderately well drained and have a silty clay loam surface layer and silty clay loam and silty clay subsoil. The well drained Norge soils have a silt loam surface layer and a silty clay loam subsoil.

The minor soils in this map unit are the Ivan, Osage, and Reading soils. The well drained Ivan soils are on low terraces and flood plains. The well drained Reading soils are on higher terraces that are rarely flooded. The poorly drained Osage soils are in slightly depressional areas on low terraces.

These soils are used mainly for crops, but some small areas are rangeland or pasture. These soils are well suited to all dryland crops and grasses commonly grown in the county. Wheat, sorghum, alfalfa, and soybeans are the main crops grown, but the soils are well suited to woodland. Flooding is a hazard on the lower lying soils that are adjacent to the stream channels. Water erosion is a hazard on the sloping Norge soils.

If adequately protected against erosion and flooding, these soils have good potential for cultivated crops and rangeland. The potential of these soils for most engineering uses is fair to poor because of the hazard of flooding. The potential is good for openland wildlife habitat.

4. Labette-Dwight-Irwin

Moderately deep and deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a clayey or silty subsoil; on uplands

This map unit is on upland divides that are broad and smooth and are dissected by intermittent streams.

This map unit makes up about 12 percent of the county. It is about 50 percent Labette soils, 20 percent Dwight soils, 15 percent Irwin soils, and 15 percent soils of minor extent.

The nearly level to moderately sloping Labette and Dwight soils are on ridgetops and side slopes. The gently sloping Irwin soils are on broad ridgetops. The well drained Labette soils have a silty clay loam surface layer, a silty clay loam and silty clay subsoil, and a silty clay loam substratum. Limestone is at a depth of about 36 inches. The moderately well drained Dwight soils have a silt loam surface layer and a silty clay subsoil and substratum. The well drained Irwin soils have a silty clay loam surface layer and silty clay subsoil and substratum. Many alkali spots occur throughout this map unit.

The minor soils in this map unit are the moderately well drained Clime and Verdigris soils, the well drained Smolan soils, and the somewhat excessively drained Sogn soils. Clime and Sogn soils are near limestone and shale outcrops on ridgetops. Smolan soils are on side slopes. Verdigris soils are on narrow flood plains along intermittent streams.

About 75 percent of the acreage is used for crops, and the remainder is rangeland. These soils are moderately well suited to all the dryland crops and grasses commonly grown in the county. Wheat and sorghum are the main crops. Water erosion is a hazard.

If adequately protected against erosion, these soils have good to fair potential for cultivated crops and rangeland. The potential of the soils for most engineering uses is poor. High shrink-swell potential and low strength are limitations. The potential for openland wildlife habitat is fair to good.

5. Clime-Sogn-Martin

Shallow to deep, gently sloping to steep, moderately well drained and somewhat excessively drained soils that have a clayey or silty subsoil or lack a subsoil; on uplands

This map unit makes up about 30 percent of the county. It is about 30 percent Clime soils, 25 percent Sogn soils, 20 percent Martin soils, and 25 percent soils of minor extent (fig. 3).

Strongly sloping Clime and Sogn soils are on narrow ridgetops and on breaks and side slopes. They contain areas of shale and limestone rock outcrop. Typically the Sogn soils are on the ridgetops, and the Clime soils are on the side slopes. The deeper Martin soils are on lower slopes below the Clime and Sogn soils. The moderately well drained Clime soils have a silty clay surface layer, a silty clay subsoil, and, at a depth of about 36 inches, a substratum of silty clay and calcareous shale. The somewhat excessively drained Sogn soils have a surface layer of silty clay loam and have a substratum of limestone at a depth of about 10 inches. The moderately well drained Martin soils have a silty clay loam surface layer and a silty clay loam and silty clay subsoil.

The minor soils in this map unit are the moderately well drained Dwight and Verdigris soils and the well drained Labette soils. Dwight and Labette soils are on ridgetops, and Verdigris soils are on flood plains of narrow upland drainageways.

About 85 percent of the acreage of these soils is rangeland that is used for the production of beef cattle. The remainder is cultivated to small grain. The soils are well suited to rangeland. Major concerns of range management are the hazard of erosion and the low available water capacity.

If adequately protected from overstocking and overgrazing, these soils have good potential for rangeland. Potential is poor for crops; slope and depth to bedrock are limitations. Potential of the soils for most engineering uses is poor, because the soils are limited by high shrink-swell potential, low strength, and depth to bedrock. Potential is fair to good for rangeland wildlife habitat.

6. Florence-Martin-Labette

Deep and moderately deep, gently sloping to strongly sloping, well drained and moderately well drained soils that have a cherty clay subsoil or clayey and silty subsoil; on uplands

This map unit makes up about 13 percent of the county. It is about 55 percent Florence soils, 20 percent Martin soils, 10 percent Labette soils, and 15 percent soils of minor extent (fig. 4).

Florence soils are on convex slopes of ridgetops and side slopes. Martin soils are on side slopes near drainageways. Labette soils are on ridgetops. Florence and Labette soils are well drained, and Martin soils are moderately well drained. Florence soils have a cherty silt loam surface layer, a cherty silty clay loam and cherty clay subsoil, and a cherty limestone substratum. Martin soils have a silty clay loam surface layer and a silty clay loam and silty clay subsoil. Labette soils have a silty clay loam surface layer, a silty clay loam and silty clay subsoil, and a substratum of silty clay loam. Limestone is at a depth of 36 inches.

The minor soils in this map unit are the Clime, Sogn, Dwight, Reading, and Ivan soils. Dwight and Clime soils are moderately well drained. Reading and Ivan soils are well drained, and Sogn soils are somewhat excessively drained. Clime and Sogn soils are on ridgetops near breaks. Dwight soils are also on ridgetops, and Reading and Ivan soils are along drainageways.

Most of these soils are rangeland, but some small areas along drainageways are cultivated to small grain. The production of beef cattle is the main farm enterprise. The soils are well suited to rangeland. The major concern of range management is the hazard of erosion.

If adequately protected from overstocking and overgrazing, these soils have good potential for rangeland. Potential is fair to poor for crops because slope and a stony surface layer are limitations. Potential is fair to poor for most engineering uses, because the soils are limited by shrink-swell potential and low strength. Potential is fair to good for rangeland wildlife habitat.

7. Labette-Smolan-Sogn

Deep to shallow, gently sloping to moderately sloping, well drained and somewhat excessively drained soils that have a clayey and silty subsoil or lack a subsoil; on uplands

This map unit makes up about 14 percent of the county. It is about 45 percent Labette soils, 35 percent Smolan soils, 10 percent Sogn soils, and 10 percent soils of minor extent.

Labette soils are on ridgetops, and Smolan soils are on side slopes, where the soils are thicker. Sogn soils are on breaks between the ridgetops and the side slopes, and in places they contain areas of limestone outcrops. The well drained Labette soils have a silty clay loam surface layer, a silty clay loam and silty clay subsoil, and at a depth of 36 inches, a substratum of silty clay loam and limestone. The well drained Smolan soils have a silty clay loam surface layer, a silty clay loam and silty clay subsoil, and a silty clay loam substratum. The somewhat excessively drained Sogn soils have a silty clay loam surface layer and a substratum of limestone at a depth of about 10 inches.

The minor soils in this map unit are the well drained Irwin soils and the moderately well drained Dwight and Verdigris soils. Dwight and Irwin soils are on ridgetops, and Verdigris soils are on narrow flood plains along intermittent streams.

Most areas of these soils are used for crops. Some small areas of Sogn soils near rock outcrop are used for range. These soils are well suited to all dryland crops and grasses commonly grown in the county. Wheat, sorghum, and alfalfa are the main crops. Water erosion is a hazard.

If adequately protected against erosion, these soils have good potential for cultivated crops and rangeland. The potential of these soils is poor for most engineering uses. High shrink-swell potential, low strength, or shallow bedrock are limitations for these uses. Potential is good to fair for openland wildlife habitat.

8. Vanoss-Bethany-Tabler

Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a silty or clayey subsoil; on uplands

This map unit makes up about 12 percent of the county. It is about 35 percent Vanoss soils, 20 percent Bethany soils, 15 percent Tabler soils, and 30 percent soils of minor extent.

Vanoss soils are nearly level to moderately sloping. The nearly level and gently sloping Bethany soils are on ridgetops. Tabler soils are mostly nearly level, and the slopes are concave. Vanoss and Bethany soils are well drained, and Tabler soils are moderately well drained. Vanoss soils have a silt loam surface layer and a silty clay loam and silt loam subsoil. Bethany soils have a silt loam surface layer and a silty clay loam and silty clay subsoil. Tabler soils have a silty clay loam surface layer and silty clay subsoil and substratum.

The minor soils in this map unit are the Milan, Waurika, and Norge soils. The well drained Milan and Norge soils are on side slopes and are near the Vanoss soils. The somewhat poorly drained Waurika soils are in slightly depressional areas.

Nearly all of these soils are used for cultivated crops. The soils are well suited to all the dryland crops and grasses commonly grown in the county. Wheat, sorghum, and alfalfa are the main crops. Water erosion is a hazard on all the sloping soils. Drainage is needed on some of the nearly level soils.

If adequately protected against erosion, these soils have good potential for cultivated crops and rangeland. The potential of the soils is good to fair for most engineering uses, because these soils are limited by high shrink-swell potential and low strength. The potential for openland wildlife habitat is good.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a similar profile make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Rosehill series, for example, was named for the town of Rosehill in Butler County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Norge silt loam, 1 to 3 percent slopes, is one of several phases within the Norge series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Clime-Sogn complex, 2 to 15 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these included soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Aa—Attica loamy fine sand, 3 to 6 percent slopes. This deep soil is moderately sloping and well drained. It is on uplands. Individual areas of this unit are irregular in shape and 50 acres to several hundred acres in size.

Typically the surface layer is brown loamy fine sand about 9 inches thick. The subsoil is brown, very friable fine sandy loam about 27 inches thick. The substratum, to a depth of about 60 inches, is brown fine sandy loam. In some places the surface layer is fine sandy loam. Also in places this soil has a loamy fine sand subsoil.

Included with this soil in mapping are small areas of Milan soils. Milan soils have a more clayey subsoil. They are on slopes and are below Attica soils. Also included are soils that are in small depressional areas and have a mottled clay loam subsoil. These included soils make up about 10 percent of this map unit.

Permeability is moderately rapid in this soil, and runoff is slow. The available water capacity is low, natural fertility is medium, and organic-matter content is moderate. Shrink-swell potential is low. Soil tilth is good. The reaction of the soil ranges from medium acid to neutral.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Peaches, apples, watermelons, sweet corn, and cantaloupes are grown on a small acreage. The potential of this soil is good for crops, rangeland, pasture, openland wildlife habitat, windbreaks, and most engineering uses.

This soil is suited to most crops commonly grown in the county. If the soil is cultivated but left unprotected, soil blowing is a hazard. Controlling soil blowing and conserving moisture are the main concerns of management. Returning crop residue to the soil, stripcropping, and stubble mulch tillage help control soil blowing.

This soil is also well suited to rangeland. Major concerns of range management are the hazard of soil blowing and the moderate available water capacity. Management that maintains an adequate vegetative cover and

ground mulch helps prevent soil blowing and conserve moisture. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, soil blowing, fire, and rodents are necessary for success.

This soil has slight limitations for dwellings and local roads and streets. It has slight limitations for septic tank absorption fields, but it is severely limited for sewage lagoons by the moderately rapid permeability.

This soil is in capability subclass IIIe.

Ab—Attica-Tivoli loamy fine sands, 3 to 15 percent slopes. This map unit consists of deep, rolling soils on uplands. Most individual areas of this unit are small and irregular in shape. The unit is made up of 70 percent well drained Attica soils and 25 percent excessively drained Tivoli soils. The Tivoli soils are on steep side slopes, and the Attica soils are on lower, gently undulating slopes between the Tivoli soils. The two soils are so intricately mixed, or the acreage of each is so small, that it is not practical to separate them in mapping.

Typically, the Attica soil has a surface layer of brown loamy fine sand about 9 inches thick. The subsoil is brown, very friable fine sandy loam about 27 inches thick. The substratum, to a depth of about 60 inches, is brown, fine sandy loam.

Typically, the Tivoli soil has a surface layer of brown loamy fine sand about 7 inches thick. The substratum is very pale brown fine sand, which extends to more than 60 inches in depth.

Included with these soils in mapping are small areas of moderately well drained soils in shallow depressions. These soils have a loamy fine sand surface layer, and the subsoil is mottled clay loam. These soils make up about 5 percent of the unit.

Permeability is moderately rapid in the Attica soil and rapid in the Tivoli soil. Surface runoff is slow on the Attica soil, and very slow on the Tivoli soil. The available water capacity is low for both soils. In both soils, fertility is medium, and organic-matter content is moderate. Shrink-swell potential is low for both soils. Reaction ranges from medium acid to neutral in the Attica soil and from slightly acid to mildly alkaline in the Tivoli soil.

Most areas of these soils remain in native grass and are used for grazing. The potential of these soils is good for rangeland. It is poor for crops and pasture, because soil blowing is a hazard. The potential is good to fair for most engineering uses and fair for openland wildlife habitat and wind breaks.

This unit is best suited to rangeland. Major concerns of range management are the hazard of soil blowing and the low available water capacity. Management that maintains an adequate vegetative cover and ground mulch helps prevent soil blowing and conserve moisture. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. The taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system improve range condition.

This unit is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from soil blowing, livestock, fire, and rodents are necessary for success.

These soils have slight to moderate limitations for dwellings, because slopes are steep in some places. Buildings can be constructed on the less sloping Attica soils. Steep slopes are also a moderate limitation for local roads and streets. Limitations for septic tank absorption fields are moderate for the steeper Tivoli soils, but they are slight for the Attica soils. These soils are severely limited for sewage lagoons by the rapid permeability.

These soils are in capability subclass VIe.

Ba—Bethany silt loam, 0 to 1 percent slopes. This deep soil is nearly level and well drained. It is on broad, smooth ridgetops in uplands. Individual areas of this unit range from about 30 to 200 acres.

Typically, the surface layer is grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark grayish brown, friable silty clay loam. The middle part is grayish brown and brown, very firm silty clay that contains some small lime concretions and a few fine, faint, brownish yellow mottles. The lower part is light brown, very firm silty clay loam that contains common, coarse, distinct yellowish red mottles and small black concretions. In some places the depth to the silty clay subsoil is less than 14 inches. In other places the subsoil is silty clay loam throughout.

The surface layer is friable and easily tilled. Permeability and runoff are slow. Available water capacity and fertility are high, and the organic-matter content is moderate. Reaction is medium acid to neutral in the surface layer, slightly acid or neutral in the upper part of the subsoil, and mildly alkaline or moderately alkaline in the lower part. Shrink-swell potential is high.

Most areas of this soil are used for wheat, sorghum, and alfalfa. The potential is good for crops, rangeland, pasture, windbreaks, and openland wildlife habitat. It is fair for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic-matter content. Returning crop residue to the soil and minimum tillage help conserve moisture. Erosion is not a hazard. This soil is well

suited to leveling for irrigation, if adequate water is available.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation of low strength for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. It is suited to sewage lagoons.

This soil is in capability class I.

Bb—Bethany silt loam, 1 to 3 percent slopes. This deep soil is gently sloping and well drained. It is on broad side slopes in uplands. Individual areas of this unit range from 20 to 200 acres.

Typically, the surface layer is grayish brown silt loam about 9 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark grayish brown, friable silty clay loam. The middle part is grayish brown, very firm silty clay that contains some small lime concretions and a few fine, faint brownish yellow mottles. The lower part is light brown, very firm silty clay loam. It contains common, coarse, distinct yellowish red mottles and small black concretions. In some places the depth to the silty clay subsoil is less than 14 inches, and the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Vanoss soil. Vanoss soils are less clayey than the Bethany soil and are on the lower part of slopes. This included soil makes up about 5 percent of the unit.

The surface layer is friable and easily tilled. Permeability is slow, and runoff is medium. Available water capacity and natural fertility are high, and the organic-matter content is moderate. Reaction is medium acid to neutral in the surface layer, slightly acid or neutral in the upper part of the subsoil, and mildly alkaline or moderately in the lower part. Shrink-swell potential is high in the subsoil.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential is good for crops, rangeland, pasture, windbreaks, and openland wildlife habitat. It is fair for most engineering uses.

This soil is well suited to growing small grain, sorghum, and alfalfa (fig. 5). Water erosion is a hazard if the soils are cultivated but left unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth. This soil can be readily leveled for irrigation if adequate water is available.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation of low strength for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. It is suited to sewage lagoons.

This soil is in capability subclass IIe.

Bc—Brewer silty clay loam. This deep soil is nearly level and moderately well drained. It is in broad areas on low terraces and flood plains principally along the Walnut River. It is rarely flooded, and crop damage is slight. Individual areas of this unit range from 80 to 400 acres.

Typically, the surface layer is dark grayish brown silty clay loam about 15 inches thick. The firm and very firm subsoil is 45 inches thick. The upper part is grayish brown silty clay. The middle part is grayish brown silty clay that contains a few strong brown mottles. The lower part is brown silty clay loam that contains some dark yellowish brown mottles. In some places the surface layer is less than 10 inches thick.

Included with this soil in mapping are small areas of poorly drained Osage soils and small areas of less clayey Verdigris soils. Osage soils are in shallow depressions. The landscape position of the Verdigris soil is similar to that of the Brewer soil. The included soils make up about 10 percent of the unit.

The surface layer is friable and easily tilled. Permeability is slow, and available water capacity is high. Runoff is slow, natural fertility is high, and the organic-matter content is moderate. Reaction is slightly acid or neutral in the surface layer, neutral or mildly alkaline in the upper part of the subsoil, and neutral to moderately alkaline in the lower part. Shrink-swell potential is high.

Most areas of this soil are used for wheat. The potential of this soil is good for crops; rangeland; openland and woodland wildlife habitat; pasture; and windbreaks. It is fair for most engineering uses.

This soil is well suited to small grain, soybeans, sorghum, and alfalfa. The slow permeability moderately limits the choice of crops and the timing of tillage. Tillage that is performed when the soil is too wet or too dry causes the soil to be cloddy. Minimum tillage performed at optimum moisture conditions and returning crop residue to the soil help to maintain tilth, organic-matter content, and fertility. This soil can be readily leveled for irrigation.

This soil is well suited to rangeland. It receives extra moisture from surrounding areas and from flooding. Grazing when the soil is too wet causes surface compaction and poor tilth. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle help improve range.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and the hazard of flooding. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Flooding can be controlled by dikes or levees. This soil has a severe limitation of low strength for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. It is suited to sewage lagoons.

This soil is in capability class I.

Ca—Canadian fine sandy loam. This deep soil is nearly level and well drained. It is in long narrow areas on stream terraces along the Arkansas River. It is rarely flooded in most places, but occasional flooding may occur where the Walnut River joins the Arkansas River. Individual areas of this unit range from 30 to 200 acres.

Typically, the surface layer is grayish brown fine sandy loam about 16 inches thick. The subsoil is brown, very friable fine sandy loam about 12 inches thick. The substratum, to a depth of about 60 inches, is yellowish brown and light yellowish brown fine sandy loam. In some places the subsoil and substratum are loamy fine sand. In other places the subsoil is calcareous below 20 inches, and also contains faint mottles. Some areas have a more sandy surface layer.

Included with this soil in mapping are small areas of Lesho and Dale soils. The landscape position of the included soils is similar to that of the Canadian soil. These soils are more clayey than Canadian soils. The Lesho soils are somewhat poorly drained. The included soils make up about 10 percent of the unit.

The surface layer is very friable and easily tilled. Permeability is moderately rapid, available water capacity is moderate, and runoff is slow. The organic-matter content is moderate and fertility is medium. Reaction ranges from slightly acid to neutral in the surface layer and from slightly acid to moderately alkaline in the subsoil. Shrink-swell potential is low.

Most areas of this soil are used for wheat and sorghum. Some alfalfa is grown. The potential of this soil is good for crops; rangeland; openland, rangeland, and woodland wildlife habitat; pasture; windbreaks; vegetable gardens; and fruit orchards. It is fair for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Soil blowing is a hazard in cultivated areas during short periods when there is no vegetative cover. Returning crop residue to the soil and minimum tillage help control soil blowing and conserve moisture. This soil is well suited to irrigation.

This soil is well suited to rangeland. It receives extra moisture as runoff from adjacent upland soils or from flooding. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings and moderately limited for local roads and streets and septic tank absorption fields by the hazard of flooding. The soil is severely limited for sewage lagoons by seepage. Sealing the lagoon helps reduce seepage.

This soil is in capability subclass IIe.

Cb—Clime-Rock outcrop complex, 15 to 35 percent slopes. This map unit consists of steep soils that are moderately deep and moderately well drained and of steep rock outcrops. It is on upland breaks and side slopes (fig. 6). It presents an intricate pattern of limestone and shale rock escarpments alternating with steep and moderately steep soil. Individual areas of this unit are irregular in shape and range from 40 to 800 acres in size. This map unit is about 55 percent Clime soils and 25 percent Rock outcrop. Clime soils are on slopes of less than 25 percent, and Rock outcrop is on the steeper escarpments. Clime soils and Rock outcrop are so intricately mixed, or the acreage of each is so small that it is not practical to separate them in mapping.

Typically, the Clime soil has a dark gray silty clay surface layer about 6 inches thick. The subsoil is grayish brown very firm silty clay about 12 inches thick. The substratum, about 16 inches thick, is light gray, massive silty clay that contains shale fragments. Olive gray and light olive brown, calcareous shale is at a depth of about 36 inches. In some places the surface layer contains shale fragments.

Typically, Rock outcrop consists of exposures of bare limestone or shale bedrock and some weathered limestone or shale materials in between the bedrock.

Included in mapping are small areas of shallow Sogn soils in similar positions on the landscape. Also included are a few small areas of shallow soils that have a light colored surface layer and a few small areas of soils that have sandstone rock outcrop. These included soils make up 15 percent of the unit.

Clime soils have moderately slow permeability and moderate available water capacity. Runoff is rapid. The natural fertility is high, and the organic-matter content is moderate. Reaction is mildly alkaline to moderately alkaline throughout the soil. The root zone extends to shale bedrock. Shrink-swell potential is moderate.

About 75 percent of the soil supports trees (fig. 7) and brush and 25 percent is covered by native grass. This map unit is used for grazing. Potential of the soil is fair for windbreaks and rangeland. Potential is good for woodland and wildlife habitat. It is poor for crops, pasture, and most engineering uses.

This unit is best suited to rangeland. Major concerns of range management are the hazard of erosion and the moderate available water supply. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and planned grazing systems help keep the range and soil in good condition.

This unit is moderately well suited to trees grown as windbreaks and the environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by steep slopes, moderate shrink-swell potential, and rock outcrop. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. The soil is severely limited for local roads and streets by steep slopes, rock outcrop, and low strength. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability and depth to rock. It is severely limited for sewage lagoons by depth to rock and steep slopes.

This unit is in capability subclass VIIe.

Cc—Clime-Sogn complex, 2 to 15 percent slopes. This map unit consists of moderately deep and shallow soils that are gently sloping to strongly sloping. It is on upland ridges and side slopes. Clime soils are moderately well drained, and Sogn soils are somewhat excessively drained. The unit has numerous rock outcrops near the ridgetop. Individual areas of this unit range from 100 acres to several thousand acres. This unit is made up of about 60 percent Clime soils and 20 percent Sogn soils. The Clime soils are on long side slopes below ridgetops. Sogn soils occur on nearly levely ridgetops and on alternating benches downslope from the Clime soils. The two soils are so intricately mixed, or the acreage of each is so small, that it is not practical to separate them in mapping.

Typically the Clime soil has a dark gray silty clay surface layer about 8 inches thick. The subsoil is grayish brown, very firm silty clay about 12 inches thick. The substratum, about 16 inches thick, is light gray, massive silty clay that contains shale fragments. Olive gray and light olive brown, calcareous shales are at a depth of about 36 inches. In some places the surface layer contains shale fragments.

Typically the Sogn soil has a dark grayish brown, silty clay loam surface layer about 10 inches thick. The surface layer is over level-bedded limestone. In some places the surface layer contains fragments of limestone.

Included with these soils in mapping are small areas of Martin soils, limestone and shale outcrops, and deep soils that have a clayey surface layer and subsoil. A few small areas of soils that have sandstone rock outcrop are in this unit. Martin soils are on side slopes below Clime soils. Limestone and shale outcrops are on some of the steeper points and breaks. Clayey soils are on foot slopes near the base of Clime soils and are next to the limestone benches. The included soils make up about 20 percent of the map unit.

Permeability is moderately slow in the Clime soil and moderate in the Sogn soil. The available water capacity is moderate for the Clime soil and very low for the Sogn soil. Shrink-swell potential is moderate in both soils. Reaction is mildly alkaline to moderately alkaline throughout the Clime soil and slightly acid to moderately alkaline throughout the Sogn soil. Natural fertility is high in the Clime soil and medium in the Sogn soil. Organic-matter content is moderate in the Clime soil and moderate to low in the Sogn soil. The root zone extends to shale bedrock in the Clime soil and to limestone bedrock in the Sogn soil.

Most areas of these soils remain in native grass and are used for grazing. The potential of these soils is fair to good for rangeland and pasture, but it is fair to poor

for rangeland wildlife habitat. It is fair for windbreaks and poor for crops and most engineering uses.

This map unit is best suited to rangeland. Major concerns of range management are the hazard of erosion and the moderate to very low available water capacity. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition. Pond reservoir sites are plentiful (fig. 8).

This unit is moderately well suited to trees grown as windbreaks and environmental plantings. The shallowness to bedrock, however, prevents growth on the Sogn soils. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

These soils are severely limited for dwellings by moderate shrink-swell potential and depth to rock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. The soils have severe limitations of low strength and depth to rock for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. The soils are severely limited for septic tank absorption fields by slow permeability and depth to rock. They have severe limitations for sewage lagoons, because of depth to rock. Sewage lagoons can generally be located on the deeper included soils.

This unit is in capability subclass VIe.

Da—Dale silt loam. This deep soil is nearly level and well drained. It is on stream terraces that are rarely flooded. Individual areas, long, broad, and continuous, are along the Arkansas River. They range from 40 to 1,500 acres.

Typically, the surface layer is grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 19 inches thick. The subsoil is brown, friable silt loam about 14 inches thick. It is calcareous and contains some films and accumulations of soft lime. The substratum, to a depth of 60 inches, is yellowish brown, calcareous loam. In some places the surface layer and subsoil are loam.

Included with this soil in mapping are small areas of Canadian and Lesho soils. Canadian soils have a fine sandy loam surface layer and subsoil. Lesho soils have more clay in the solum and are somewhat poorly drained. Canadian and Lesho soils are on lower positions on the landscape than Dale soils. The included soils make up about 10 percent of the unit.

The surface layer is friable, and tilth is good. Permeability is moderate on this soil, and available water capacity is high. Runoff is slow. The natural fertility is high, and organic-matter content is moderate. Reaction ranges from slightly acid to neutral in the surface layer and from slightly acid to moderately alkaline in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil are cultivated. Wheat, sorghum, and alfalfa are the principal crops. Potential of this soil is good for crops; rangeland; openland and woodland wildlife habitat; pasture; and windbreaks. It is fair for most engineering uses.

This soil is well suited to growing small grain, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic-matter content. Returning crop residues to the soil and minimum tillage help conserve moisture. This soil is well suited to irrigation.

This soil is well suited to rangeland. It receives extra moisture from adjacent uplands. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings and local roads and streets by the hazards of flooding. Constructing dikes and levees reduces the hazard of flooding. This soil is severely limited for septic tank absorption fields by flooding. It has a moderate limitation of seepage for sewage lagoons. Sealing the lagoon reduces seepage.

This soil is in capability class I.

Db—Dwight silt loam. This deep soil is nearly level and moderately well drained. It is in irregularly shaped areas on broad upland ridges and side slopes near limestone outcrops. Individual areas of this map unit range from 20 to 100 acres.

Typically, the surface layer is grayish brown silt loam about 5 inches thick. The subsoil is about 39 inches thick. The upper part is dark grayish brown, extremely firm silty clay that contains a few lime concretions. The lower part is extremely firm silty clay that has strong brown and light gray mottles and soft lime accumulations. The substratum is massive silty clay that is mixed colors of pale brown, brownish yellow, olive yellow, and olive. It contains fragments of shale and limestone. Hard limestone bedrock is at a depth of 54 inches. In some places the surface layer is light colored silty clay loam, where the surface is puddled when wet and crusted when dry. Also, in some places the surface layer is clayey,

where soil material from the upper part of the subsoil has been mixed with the surface soil.

Included with this soil in mapping are small areas of Irwin and Labette soils. Irwin soils have a silty clay loam surface layer about 13 inches thick. Labette soils are less than 40 inches deep to limestone. The landscape position of the included soils is similar to that of the Dwight soils. Included soils are in areas less than 3 acres in size and make up about 10 percent of the map unit.

The surface layer is friable and has fair tilth, except where the surface is crusted or eroded. Permeability is very slow, and available water capacity is moderate. Surface runoff is medium. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The shrink-swell potential is high. The soil contains sodium salt, and alkali spots are common.

About one-half of the acreage is used for wheat and sorghum, and one-half is rangeland. Potential of the soils is fair for crops; rangeland; pasture; and openland and rangeland wildlife habitat. It is poor for windbreaks and most engineering uses.

This soil is moderately well suited to most commonly grown cultivated crops in the county. The moderate available water capacity limits plant growth during summer months.

Crops are difficult to establish on alkali spots. Erosion is a hazard if these soils are cultivated but unprotected. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terraces and contour farming help control erosion. Returning crop residue to the soil and using fertilizer help maintain fertility, organic-matter content, and tilth.

This soil is moderately well suited to rangeland. The dense subsoil restricts the penetration of moisture and the development of roots. The soil does not release moisture readily to plants. Because this soil takes in and releases moisture slowly, this soil is droughty and low in forage production. Overgrazing or grazing when the soil is too wet causes surface compaction. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help keep the range and soil in good condition.

This soil is poorly suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has a severe limitation of low strength for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by very slow permeability. It has moderate limitations for sewage lagoons, because of the depth to rock. Sewage lagoons, however, can be located in areas where the included soils are deeper.

This soil is in capability subclass IVs.

Fa—Florence cherty silt loam, 5 to 15 percent slopes. This deep soil is moderately sloping to strongly sloping and well drained. It is on ridgetops and side slopes. Individual areas are irregularly shaped and from 100 to 2,000 acres.

Typically the surface layer is very dark grayish brown cherty silt loam about 14 inches thick. The subsoil is about 31 inches thick. The upper part is dark reddish gray, firm cherty silty clay loam. The lower part is reddish brown, extremely firm coarse cherty clay. The substratum to a depth of about 45 inches, is cherty limestone. In some places a light brown subsurface layer is below the surface layer, and the depth to cherty clay is about 30 inches.

Included with this soil is mapping are small areas of Dwight, Labette, and Martin soils and limestone outcrops. Dwight and Martin soils lack a cherty clay subsoil. Dwight soils are on ridgetops and Martin soils are on side slopes. Labette soils are 20 to 40 inches deep to limestone. They are on ridgetops. Limestone outcrops are at steeper points and breaks. These included soils make up about 15 percent of the unit.

The surface layer is friable and tilth is good. Permeability is moderately slow, and available water capacity is low. Surface runoff is rapid. The natural fertility is medium, and the organic-matter content is moderate. Reaction ranges from slightly acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil remain in native grass and are used for grazing (fig. 9). Potential of the soil is good habitat for rangeland and pasture and fair for rangeland wildlife habitat. It is poor for crops. It is fair for windbreaks and most engineering uses.

This unit is well suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the range and soil in good condition. Potential pond reservoir sites are plentiful.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing

vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage. This soil has a moderate limitation of low strength for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. It is severely limited for sewage lagoons by small stones. Increasing the size of the absorption field improves the function of the septic tank system.

This soil is in capability subclass VIe.

Ia—Irwin silty clay loam, 1 to 3 percent slopes. This deep soil is gently sloping and well drained. It is on broad ridgetops and side slopes. Individual areas of this unit are irregular in shape and range from 20 to 500 acres in size.

Typically the surface layer is dark grayish brown silty clay loam about 13 inches thick. The subsoil is about 27 inches thick. The upper part is dark grayish brown, very firm silty clay. The lower part is brown, extremely firm silty clay that contains some small lime concretions. The substratum is pale brown, very firm silty clay that extends to a depth of more than 60 inches. It contains some dark brown and strong brown mottles. In some places the surface layer has been eroded and is less than 8 inches thick. In small areas this soil is severely eroded.

Included with this soil in mapping are small areas of Dwight, Rosehill, and Smolan soils. Dwight soils have a thin silt loam surface layer. Rosehill soils are 20 to 40 inches deep to shale. Smolan soils have a reddish brown subsoil. The landscape position of the included soils is similar to that of the Irwin soil. These included soils make up about 15 percent of the map unit.

The surface layer is firm, and tilth is poor. Clods form and structure is destroyed if the soil is worked when too wet or too dry. Permeability is very slow, available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is high.

About 75 percent of this soil is used for wheat, sorghum, and alfalfa; the remainder is range. Potential of the soil is good for crops, rangeland, pasture, windbreaks, and openland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to growing small grains, sorghum, and alfalfa. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terraces and contour farming are management practices that help control erosion. Returning crop residue to the soil and using fertilizer help maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch help prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations of low strength and high shrink-swell potential for local roads and streets. This limitation can be lessened by strengthening or replacing base material. This soil is severely limited for septic tank absorption fields by very slow permeability. It has a moderate limitation for sewage lagoons because of the slope. Sewage lagoons can generally be located in less sloping areas.

This soil is in capability subclass IIIe.

Ib—Ivan silt loam. This deep soil is nearly level and well drained. It is in long, narrow, continuous areas on flood plains along Grouse and Silver Creeks (fig. 10). Flooding is occasional, but the duration of flooding is brief. Individual areas of this unit range from 50 to 300 acres.

Typically the surface layer is grayish brown, calcareous silt loam about 28 inches thick. The substratum, which extends to a depth of more than 60 inches, is grayish brown, calcareous silt loam. In some places the surface layer is noncalcareous.

Included with this soil in mapping are small areas of Brewer, Reading, and Verdigris soils. Brewer and Reading soils have a more clayey subsoil and are in higher positions on the flood plain. Verdigris soils are noncalcareous throughout and are in positions on the landscape that are similar to those of the Ivan soil. Included soils make up about 15 percent of the map unit.

The surface layer is very friable and easily tilled. Permeability is moderate, available water capacity is high, and surface runoff is slow. Natural fertility is high, and organic-matter content is moderate. Reaction is mildly alkaline or moderately alkaline throughout the soil. The shrink-swell potential is moderate.

About 75 percent of this soil is used for wheat, sorghum, soybeans, and alfalfa. The remainder is in trees and native grass, and is either grazed or wasteland. Potential is good for crops, rangeland, pasture, woodland and openland wildlife habitat, and windbreaks. It is poor for most engineering uses.

This soil is well suited to growing small grain, sorghum, soybeans, and alfalfa. Soil deposition and scouring and damage to crops are hazards caused by frequent flooding. Management is needed mainly to control deposition and scouring, limit flood damage to crops, and to maintain organic-matter content and fertility. Returning crop residue to the soil and minimum tillage helps to maintain fertility and tilth.

This soil is well suited to rangeland. It receives extra moisture from adjacent uplands or from flooding. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings, septic tank absorption fields, sewer lagoons, and local roads and streets by the hazard of flooding. Construction dikes and levees help lessen the hazard of flooding.

This soil is in capability subclass IIw.

La—Labette silty clay loam, 1 to 3 percent slopes. This moderately deep soil is gently sloping and well drained. It is on ridgetops and side slopes in uplands. Individual areas of this unit are irregular in shape and range from 40 to 160 acres in size.

Typically the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm silty clay loam, and the lower part is reddish brown, very firm silty clay. The substratum is reddish brown silty clay that has fragments of soft calcareous shale. Hard limestone is at a depth of 36 inches. In some places the depth to limestone is less than 20 inches. In small areas, this soil is severely eroded.

Included with this soil in mapping are small, areas of Dwight and Irvin soils. Dwight and Irwin soils are more than 40 inches deep to bedrock. Dwight soils contain sodium salt. These included soils are on slopes similar to those of the Labette soils. These included soils make up about 15 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is slow, available water capacity is moderate, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction ranges from slightly acid to medium acid in the surface layer and from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is high. The depth to hard limestone ranges from 20 to 40 inches.

About one-half of the acreage is used for wheat, sorghum, and alfalfa, and one-half is rangeland. Potential of this soil is good for crops, rangeland, pasture, and windbreaks. It is fair as rangeland and openland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Water erosion is a hazard if the soil is cultivated but unprotected. Terraces and contour farming help to control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Major concerns of range management are the hazard of erosion and the moderate available water capacity. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitation of high shrink-swell potential and low strength for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. The soil is severely limited for septic tank absorption fields by depth to bedrock and slow permeability. It has severe limitations for sewage lagoons, because of the depth to bedrock. Sewage lagoons generally can be located on the deeper included soils.

This soil is in capability subclass IIe.

Lb—Labette silty clay loam, 3 to 7 percent slopes. This moderately deep soil is moderately sloping and well drained. It is on side slopes along drainageways in uplands. Individual areas of this unit are irregular in shape and range from 20 to 80 acres in size.

Typically the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown, firm silty clay loam. The lower part is reddish brown, very firm silty clay. The substratum is reddish brown silty clay that has fragments of soft calcareous shale. Hard limestone is at

a depth of 36 inches. In some places the depth to limestone or calcareous shale is more than 40 inches. Included are small, severely eroded areas.

Included with this soil in mapping are small areas of Martin and Sogn soils. Martin soils are on the lower part of side slopes below Labette soils. Sogn soils are on the upper part of slopes near ridgetops. Martin soils are more than 40 inches deep to limestone or shale. Sogn soils are less than 20 inches deep to limestone. These included soils make up about 10 percent of the unit.

The surface layer is friable and has good tilth, except in places where the soil is eroded. Permeability is slow, available water capacity is moderate, and surface runoff is rapid. Natural fertility is medium, and organic-matter content is moderate. Reaction ranges from slightly acid to medium acid in the surface layer, and from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is high. The depth to hard limestone or shale ranges from 20 to 40 inches.

About 75 percent of this soil is used for rangeland. The remainder is used for wheat, sorghum, alfalfa, and cool-season grasses. This soil has good potential for rangeland, pasture, and windbreaks. Potential is fair for crops and rangeland and openland wildlife habitat. It is poor for most engineering uses.

This soil is moderately well suited to small grain, sorghum, alfalfa, and cool-season grasses. Erosion is a hazard if this soil is cultivated but unprotected. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terraces and contour farming help control erosion. Returning crop residue to the soil and use of fertilizer help maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Major concerns of range management are the hazard of erosion and the moderate available water capacity. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential, low strength, and depth to bedrock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations of low strength and high shrink-swell potential for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability and depth to bedrock. This soil has severe limitations for sewage lagoons, because of the depth to bedrock. Sewage lagoons can generally be located in the deeper included soils.

This soil is in capability subclass IIe.

Lc—Labette silty clay loam, 2 to 7 percent slopes, eroded. This moderately deep soil is moderately sloping and well drained. It is on side slopes along drainageways in uplands. Rills are common on upper slopes. Individual areas of this soil are irregular in shape and range from 20 to 80 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. Part of the orginal surface layer has been removed by erosion, and material from the subsoil has been mixed into the remaining surface layer by plowing. The subsoil is about 20 inches thick. The upper part is dark brown, firm silty clay loam. The lower part is reddish brown very firm silty clay. The substratum is reddish brown silty clay that contains fragments of soft calcareous shale. Hard limestone is at a depth of 30 inches. In some places the depth to limestone or calcareous shale is more than 40 inches. In some places dark brown subsoil is exposed at the surface. In other places, on the lower side slopes, the surface layer is thicker.

Included with this soil in mapping are severely eroded soils that are less than 20 inches deep to limestone. These severely eroded soils make up about 10 percent of the unit. Also included are Martin soils, which are on the lower part of slopes, and are more than 40 inches to limestone or shale. The Martin soils make up about 5 percent of the map unit.

The surface layer is firm and has poor tilth. Permeability is slow, available water capacity is moderate, and surface runoff is rapid. Natural fertility is low, and organic-matter content is moderately low because the surface soil has been lost through erosion. Reaction ranges from slightly acid to medium acid in the surface layer and from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is high. The depth to hard limestone or shale ranges from 20 to 40 inches.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Some areas have been abandoned or reseeded to native grasses. Potential is good for rangeland and pasture. It is fair for crops, rangeland and openland wildlife habitat, and windbreaks. It is poor for most engineering uses.

This soil is poorly suited to most commonly grown cultivated crops, because continued erosion is a hazard. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terracing, contour farming, minimum tillage, carefully selected cropping systems, and use of fertilizer help reduce runoff; conserve moisture; maintain fertility, organic-

matter content, and tilth; and control further erosion. Seeding tame grasses is also effective in controlling further erosion.

This soil is moderately well suited to rangeland. Major concerns of range management are past erosion and the hazard of further erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetation cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help to keep the range and soil in good condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential, low strength, and depth to bedrock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations of low strength and high shrink-swell potential for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability and depth to bedrock. This soil has severe limitations for sewage lagoons because of the depth to bedrock. Sewage lagoons can generally be located on the deeper included soils.

This soil is in capability subclass IIIe.

Ld—Labette-Dwight complex, 1 to 3 percent slopes. This map unit consists of moderately deep and deep soils that are nearly level to gently sloping and are moderately well drained and well drained. It is on broad upland divides. Individual areas of this unit are irregular in shape and range from 40 acres to more that 500 acres in size. This unit is made up of about 55 percent Labette soils and 35 percent Dwight soils. The two soils are so intricately mixed, or the acreage of each is so small that it is not practical to separate them in mapping.

Typically, the Labette soil has a dark grayish brown, silty clay loam surface layer about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm silty clay loam. The lower part is reddish brown, very firm silty clay. The substratum is reddish brown silty clay that has fragments of soft calcareous shale. Hard limestone is at a depth of 36 inches. In some places the depth to limestone is less than 20 inches.

Typically, the Dwight soil has a grayish brown, silt loam surface layer about 5 inches thick. The subsoil is about 39 inches thick. The upper part is dark grayish brown, extremely firm silty clay. The lower part is brown, extremely firm silty clay that contains a few lime concretions and has strong brown and light gray mottles. The substratum is massive silty clay that has mixed colors of pale brown, brownish yellow, olive yellow, and olive. It contains fragments of shale and limestone. Hard limestone bedrock is at depths of about 54 inches. In some places where the surface puddles when wet and crusts when dry, the surface layer is light colored silty clay loam. In small areas, these soils are severely eroded.

Included with these soils in mapping are small areas of Irwin soils and limestone outcrops. Irwin soils have a thicker surface layer than Dwight soils and occur on side slopes near the outer edge of the map unit. This included soil makes up 5 percent of the unit.

Permeability is slow in the Labette soil and very slow in the Dwight soil. The Dwight soil contains sodium salt, and alkali spots are common. In both soils, available water capacity is moderate, and surface runoff is medium. Tilth in both soils is fair to good. Natural fertility is medium, organic-matter content is moderate. Reaction ranges from medium acid to neutral in the surface layer, and from slightly acid to moderately alkaline in the subsoil. Shrink-swell potential is high. The root zone extends to limestone bedrock.

About one-half the acreage of these soils is used for wheat and sorghum, and one-half is rangeland. Potential use of the soils is good for crops, rangeland, pasture, and windbreaks. It is fair for rangeland and openland wildlife habitat. It is poor for most engineering uses.

These soils are moderately well suited to growing small grain, sorghum, and alfalfa. Water erosion is a hazard if the soils are cultivated but unprotected. Terraces and contour farming help control erosion. Establishing crops is difficult on the alkali spots during dry seasons. Proper use of fertilizers and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

These soils are well suited to rangeland. Major concerns of range management are the hazard of erosion and the moderate available water capacity. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

These soils are well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

These soils are severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing founda-

tion drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. These soils are severely limited for local roads and streets by low strength, high shrink-swell potential, and depth to bedrock in the Labette soil. These limitations can be lessened by strengthening or replacing the base material. These soils are severely limited for septic tank absorption fields by slow permeability and by depth to bedrock in the Labette soil. Using a sewage lagoon or increasing the size of the absorption field helps improve the function on the septic tank system. Limitations for sewage lagoons are severe on the Labette soil and moderate on the Dwight soil because of depth to bedrock, but sewage lagoons can generally be located in areas of the deeper included soils.

This soil complex is in capability subclass IIIe.

Le—Labette-Sogn silty clay loams, 2 to 8 percent slopes. This map unit consists of moderately deep and shallow soils that are moderately sloping and well drained and somewhat excessively drained. They occur on ridgetops and side slopes in uplands. Sinkholes and depressions are common. Individual areas of this unit are irregular in shape, and range from 40 to 200 acres in size. This unit is made up of about 60 percent Labette soils and 30 percent Sogn soils. The two soils are so intricately mixed, or the acreage of each is so small, that it is not practical to separate them in mapping.

Typically, the Labette soil has a dark grayish brown silty clay loam surface layer about 7 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, firm silty clay loam. The lower part is reddish brown, very firm silty clay. The substratum is reddish brown silty clay that has fragments of soft calcareous shale. Hard limestone is at a depth of 36 inches.

Typically, the Sogn soil has a dark grayish brown, silty clay loam surface layer about 10 inches thick. Level bedded limestone is below the surface layer. In some places the surface layer contains fragments of limestone.

Included with these soils in mapping are small areas of limestone and shale outcrop. The outcrop makes up 5 percent of the unit.

Permeability is slow in the Labette soil and moderate in the Sogn soil. Available water capacity is moderate in the Labette soil and very low in the Sogn soil. Surface runoff and natural fertility are medium in both soils. Organic-matter content is moderate in the Labette soil and moderately low in the Sogn soil. Reaction ranges from medium acid to slightly acid in the surface layer of the Labette soil and from slightly acid to moderately alkaline in the Sogn soil. Shrink-swell potential is high in the Labette soil and moderate in the Sogn soil. The root zone extends to limestone bedrock.

All of the acreage in this complex remains in native grass and is used for grazing. Shallow soil and rock outcrop make common tillage operations impractical. The potential of these soils for rangeland is good, but it is fair to poor for rangeland wildlife habitat, pasture, and windbreaks. It is poor for crops and most engineering uses.

This map unit is best suited to rangeland. Major concerns of range management are erosion and the very low and moderate available water capacity. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

These soils are moderately well suited to trees grown as windbreaks and environmental plantings. The shallow depth to bedrock, however, prevents growth in the Sogn soils. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

These soils are severely limited for dwellings by high shrink-swell potential and depth to bedrock. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. These soils have severe limitations of low strength and depth to rock for local roads and streets. These limitations can be lessened by strengthening or replacing the base material on the deeper Labette soils. These soils are severely limited for septic tank absorption fields by slow permeability and depth to bedrock. These soils have severe limitations for sewage lagoons, because of the depth to bedrock.

These soils are in capability subclass VIe.

Lf—Lesho clay loam. This deep soil is nearly level and somewhat poorly drained. It is on low terraces and flood plains and is occasionally flooded. It is in small, irregularly shaped areas along the Arkansas River. Individual areas of this unit range from 20 to 100 acres.

Typically, the surface layer is calcareous clay loam about 17 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The substratum, to a depth of 24 inches, is light brownish gray, calcareous loam that contains yellowish red mottles. Below 24 inches the substratum, to a depth of 60 inches, is very pale brown, loose fine sand. In some places the surface layer is sandy loam, loam, or silty clay loam.

Included with this soil in mapping are small areas of somewhat excessively drained Lincoln soils and well drained Canadian soils. The landscape position of the included soils is similar to that of the Lesho soil. Included soils make up about 10 percent of the map unit.

The surface layer is friable and easily tilled. Permeability is moderately slow, available water capacity is moderate, and surface runoff is slow. Natural fertility is medium, and organic matter content is moderate. Reaction is mildly alkaline or moderately alkaline in the surface layer, and it ranges from mildly alkaline to strongly alkaline in the substratum. Shrink-swell potential is moderate. The seasonal high water table fluctuates between depths of 2 and 4 feet.

About one-half of the acreage is used for wheat, sorghum, and alfalfa, and one-half is rangeland. Potential of this soil is good for rangeland, pasture, and woodland wildlife habitat. It is fair for crops and windbreaks. It is poor for most engineering uses.

This soil is moderately well suited to growing small grain, sorghum, and soybean. There is a hazard of wetness, which is caused by the occasional flooding and the seasonal high water table. Alfalfa grows poorly because the soil is excessively wet. Drainage outlets are difficult to find in the landscape. Levees and dams help control flooding, and a network of drainage ditches remove flood waters and lower the seasonal high water table. Returning crop residue to the soil and minimum tillage help to maintain fertility and tilth.

This soil is well suited to rangeland. The water table is within reach of grass roots. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle improve range condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by flooding and wetness. Dikes and levees can be constructed to help control flooding, and subsurface drainage lessens the wetness. This soil is moderately limited for local roads and streets by low strength, wetness, and shrink-swell potential. These limitations can be lessened by drainage and strengthening or replacing the base material. Flooding and wetness are severe limitations for septic tank absorption fields and sewage lagoons. Sewage lagoons need to be protected from flooding and the bottom sealed to lessen seepage.

This soil is in capability subclass IIIw.

Lg—Lincoln-Tivoli complex, 0 to 10 percent slopes. This map unit consists of deep soils that are nearly level to rolling and somewhat excessively drained and excessively drained. It is on flood plains along the Arkansas River. It is occasionally flooded. Individual areas are narrow and long, and range form 20 acres to several hundred acres. This unit is made up of about 55 percent Lincoln soils and 30 percent Tivoli soils. Lincoln soils are nearly level, and Tivoli soils are on small hills. The two soils are so intricately mixed, or the acreage of each is so small, that it is not practical to separate them in mapping.

Typically, the Lincoln soil has a grayish brown, fine sandy loam surface layer about 9 inches thick. The substratum extends to depths of more than 60 inches. The upper part is pink loamy fine sand, and the lower part is reddish yellow loamy fine sand. In some places the substratum contains thin strata of clay loam.

Typically, the Tivoli soil has a brown, loamy fine sand surface layer about 7 inches thick. The substratum is very pale brown fine sand that extends to a depth of more than 60 inches. In some places the substratum contains some strong brown mottles or the surface layer is fine sand.

Included with these soils in mapping are small areas of Attica and Canadian soils. Attica and Canadian soils have a darker surface layer. The landscape position of the included soils is similar to that of the Lincoln and Tivoli soils. These included soils make up about 10 percent of the map unit.

Permeability is rapid in both the Lincoln and Tivoli soils. Available water capacity is low. Surface runoff is slow for the Lincoln soil and very slow for the Tivoli soil. Natural fertility and organic-matter content is low in both soils. Reaction ranges from mildly alkaline to moderately alkaline in the Tivoli soil. Shrink-swell potential is low.

About 75 percent of the acreage remains in native grass and trees and is used for grazing. The remainder is unused, except as wildlife habitat. Potential use of the soils is fair for rangeland, pasture, windbreaks, and openland and rangeland wildlife habitat. It is poor for crops and most engineering uses.

This unit is best suited to rangeland. Major concerns of range management are the hazard of soil blowing, low fertility, low available water capacity, and occasional flooding. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle improve range condition. Trees and brush invade rangeland on these soils.

These soils are moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from soil blowing, livestock, fire, and rodents are necessary for success.

These soils are severely limited for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons by flooding. If any development is planned, the area should be protected from flooding.

This soil complex is in capability subclass VIe.

Ma—Martin silty clay loam, 1 to 3 percent slopes. This deep soil is gently sloping and moderately well drained. It is on side slopes and foot slopes adjacent to

drainageways in uplands. Individual areas of this unit are irregular in shape and range from 50 to 100 acres in size.

Typically the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark grayish brown, firm silty clay loam. The next part is grayish brown, very firm silty clay that has a few brown mottles and common black concretions. The next part is brown, very firm silty clay that has common yellowish brown mottles, many black concretions, and few shale fragments. The lower part is yellowish brown, very firm silty clay that has common reddish yellow and strong brown mottles, many black concretions, and a few shale fragments. In some places the lower subsoil is redder.

Included with this soil in mapping are small areas of Labette and Tabler soils. Labette soils are 20 to 40 inches deep to limestone, and Tabler soils have a gray subsoil. The landscape position of the included soils is similar to that of the Martin soil. Included soils make up about 10 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is slow, available water capacity is high, and surface runoff is medium. Natural fertility is high, and organic-matter content is moderate. Reaction is slightly acid or medium acid in the surface layer and ranges from slightly acid in the upper 6 inches of the subsoil to neutral or mildly alkaline in the lower 18 inches. Shrink-swell potential is high.

About 75 percent of the acreage of this soil is used for wheat, sorghum, and alfalfa. The remainder is rangeland. Potential of this soil is good for crops, rangeland, pasture, openland and rangeland wildlife habitat, and windbreaks. It is poor for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Water erosion is a hazard if the soils are cultivated but unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. The major concerns of range management is the hazard of erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and high shrink-swell potential are severe limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil has moderate limitations for sewage lagoons because of the slope. Sewage lagoons can generally be located in less sloping areas.

This soil is in capability subclass IIe.

Mb—Martin silty clay loam, 3 to 7 percent slopes. This deep soil is moderately sloping and moderately well drained. It is on upland side slopes and foot slopes below limestone outcrops. Individual areas of this unit range from 50 to 300 acres.

Typically the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark grayish brown, firm silty clay loam. The middle part is grayish brown, very firm silty clay that has a few brown mottles and common black concretions over brown, very firm silty clay that has common yellowish brown mottles, many black concretions, and a few shale fragments. The lower part is yellowish brown, very firm silty clay that has common reddish yellow and strong brown mottles, many black concretions, and a few shale fragments. In some places, the lower part of the subsoil is redder in color. In small areas, this soil is severely eroded.

Included with this soil in mapping are small areas of Labette and Clime soils. Labette soils are 20 to 40 inches deep to limestone, and Clime soils are 20 to 40 inches deep to shale. The landscape position of the included soils is similar to that of the Martin soil. The included soils make up about 10 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is slow, available water capacity is high, and surface runoff is rapid. Natural fertility is high, and organic-matter content is moderate. Reaction ranges from slightly acid or medium acid in the surface layer and slightly acid in the upper 6 inches of the subsoil to neutral or mildly alkaline in the lower 18 inches. Shrink-swell potential is high.

About one-half of the acreage of this soil is used for wheat, sorghum, and alfalfa. The remainder is rangeland. Potential of this soil is good for crops, rangeland, pasture, openland and rangeland wildlife habitat, and windbreaks. It is poor for most engineering uses.

This soil is well suited to growing small grain, sorghum, and alfalfa. Water erosion is a hazard if the soils are cultivated but unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and high shrink-swell potential are severe limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope. Sewage lagoons, however, can be located in areas of less sloping soils.

This soil is in capability subclass IIIe.

Mc—Martin silty clay loam, 2 to 7 percent slopes, eroded. This deep soil is moderately sloping and moderately well drained. It is on upland side slopes and foot slopes below limestone outcrops. Rills are common, and gullies are formed in some places. Individual areas of this unit are irregular in shape and range from 20 to 80 acres in size.

Typically the surface layer is dark grayish brown silty clay loam about 6 inches thick. Part of the original surface layer has been removed by erosion, and material from the subsoil has been mixed into the remaining surface layer by plowing. The very firm subsoil extends to a depth of about 60 inches. The upper part is grayish brown silty clay that has a few brown mottles and common black concretions. The middle part is brown silty clay that has common yellowish brown mottles, many black concretions, and a few shale fragments. The lower part is yellowish brown silty clay that has common reddish yellow and strong brown mottles, many black concretions, and a few shale fragments. In some places the lower part of the subsoil is redder. In some areas the surface layer contains shale and limestone fragments or silty clay. On some of the lower side slopes, it is thicker.

Included with this soil in mapping are small areas of Labette and Clime soils. Labette soils are 20 to 40 inches deep to limestone, and Clime soils are 20 to 40 inches deep to shale. The landscape position of the included soils is similar to that of the Martin soil. These included soils make up 10 percent of the map unit.

The surface crusts when dry and puddles when wet. The surface layer is firm, and tilth is poor. Permeability is slow, available water capacity is high, and surface runoff is rapid. Natural fertility is low, and organic-matter content is moderately low. Reaction ranges from slightly acid or medium acid in the surface layer and slightly acid in the upper 6 inches of the subsoil to neutral or mildly alkaline in the lower 18 inches. Shrink-swell potential is high.

About one-half the acreage of this soil is used for wheat, sorghum, and alfalfa. About one-half the acreage has been abandoned or reseeded to native grasses. Potential of this soil is fair for crops and windbreaks. It is good for rangeland, pasture, and openland and rangeland wildlife habitat. It is poor for most engineering uses.

This soil is poorly suited to most commonly grown cultivated crops because continued erosion is a severe hazard. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terracing, contour farming, minimum tillage, carefully selected cropping systems, and use of fertilizer help reduce runoff; conserve moisture; maintain fertility, organic-matter content, and tilth; and control further erosion.

This soil is moderately well suited to rangeland. Major concerns of range management are past erosion and the hazard of further erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetation cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help to keep the range and soil in good condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and high shrink-swell potential are severe limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope. Sewage lagoons, however, can be located in the less sloping areas.

This soil is in capability subclass IVe.

Md—Martin-Florence complex, 2 to 12 percent slopes. This map unit consists of deep, soils that are gently sloping to strongly sloping and moderately well drained and well drained. It is on ridgetops, side slopes, and foot slopes in uplands. Individual areas of this unit are irregular in shape and range from 40 to 400 acres in size. This map unit is made up of 55 percent Martin soils and 30 percent Florence soils. The two soils are so intricately mixed, or the acreage of each is so small, that it is not practical to separate them in mapping.

Typically, the Martin soil has a dark grayish brown silty clay loam surface layer that contains some chert and is about 8 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark grayish brown, firm silty clay loam. The middle part is grayish brown, very firm silty clay that has a few brown mottles and common black concretions over brown, very firm silty clay that has common yellowish brown mottles, many black concretions, and a few shale fragments. The lower part is yellowish brown, very firm silty clay that has common reddish yellow and strong brown mottles, many black concretions, and a few shale fragments. In some places the lower subsoil is redder.

Typically, the Florence soil has a very dark grayish brown, cherty silt loam surface layer about 14 inches thick. The subsoil is about 31 inches thick. The upper part is dark reddish gray, firm cherty silty clay loam. The lower part is reddish brown, extremely firm coarse cherty clay. Cherty limestone is at a depth of about 45 inches. In some places a light brown subsurface layer is below the surface layer, and the depth to cherty clay is about 30 inches.

Included with these soils in mapping are small areas of Dwight and Labette soils and limestone outcrops. The nearly level Dwight and Labette soils are on ridgetops. In the Labette soils, limestone is at depths of 20 to 40 inches. Dwight soils have sodium salts. Limestone outcrops are in high areas near the ridgetops. The included soils make up 10 percent of the unit.

Permeability is slow in the Martin soil and moderately slow in the Florence soil. Available water capacity is high in the Martin soil and low in the Florence soil. In both soils surface runoff is rapid, and organic-matter content is moderate. Natural fertility is high in the Martin soil and medium in the Florence soil. Reaction of the surface layer ranges from slightly acid to medium acid in the Martin soil and from slightly acid to neutral in the Florence soil. Shrink-swell potential is high in the Martin soil and moderate in the Florence soil.

Most areas of these soils remain in native grass and are used for grazing. Tillage for cultivated crops is impractical because chert is in the surface layer and subsoil. Potential of these soils is good for rangeland and pasture and fair to good for windbreaks and openland and rangeland wildlife habitat. It is poor for crops. It is fair to poor for most engineering uses.

This unit is well suited to rangeland. The major concerns of range management is the hazard of erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This map unit is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This map unit is moderately to severely limited for dwellings by shrink-swell potential or low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This unit is moderately to severely limited for local roads and streets by low strength and shrink-swell potential. These limitations can be lessened by strengthening or replacing the base material. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field helps improve the function of the septic tank system. This unit is slightly to moderately limited, however, for sewage lagoons by small stones and slope.

This soil complex is in capability subclass VIe.

Me—Milan fine sandy loam, 1 to 5 percent slopes. This deep soil is gently sloping and well drained. It is on convex slopes in the uplands. Individual areas of this soil are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is brown fine sandy loam about 9 inches thick. The subsoil is about 31 inches thick. The upper part is reddish brown, firm sandy clay loam. The lower part is red, firm sandy clay loam. The substratum, to a depth of about 60 inches, is red sandy loam. In some places the surface layer is sandy loam or loam. In an area south of Silverdale, this soil has steeper slopes and the surface layer is lighter colored.

Included with this soil in mapping are small areas of Minco and Norge soils. Minco and Norge soils have a less sandy surface layer and subsoil than this Milan soil. The landscape position of the included soils is similar to that of the Milan soil. The included soils make up about 10 percent of the map unit.

The surface layer is friable and easily tilled. Permeability is moderately slow, available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of the soil is good for crops, rangeland, openland wildlife habitat, pasture, and windbreaks. It is fair for most engineering uses.

This unit is well suited to all crops commonly grown in the county. Water erosion is a hazard when this soil is cultivated. Soil blowing is also a hazard in spring and fall seasons. The main concerns of management are controlling erosion and maintaining fertility and soil tilth. Terraces and contour farming help control erosion. Stripcropping and stubble mulch tillage help reduce soil blowing, increase water intake, and maintain good tilth in the surface layer.

This unit is also well suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength is a severe limitation for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by moderately slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil has a moderate limitation for sewage lagoons because of the slope. Sewage lagoons can generally be located in less sloping areas.

This soil is in capability subclass IIe.

Mf—Minco silt loam, 3 to 7 percent slopes. This deep soil is moderately sloping and well drained. It is on convex slopes in uplands and is near the Arkansas River. Individual areas of this unit are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is brown silt loam about 15 inches thick. The subsoil, about 27 inches thick, is brown, friable silt loam. The substratum, to a depth of about 60 inches, is yellowish red silt loam. In some places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Vanoss soils. Vanoss soils have a more clayey subsoil than the Minco soil. They occur on upper parts of side slopes. The included soils make up about 10 percent of the unit.

The surface layer is friable and easily tilled. The permeability is moderate, available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction is medium acid to neutral in the surface layer and is slightly acid to neutral in the subsoil. Shrink-swell potential is low.

Most of the acreage of this unit is used for wheat, sorghum, and alfalfa. Potential of the soil is good for crops, rangeland, openland and rangeland wildlife habitat, pasture, windbreaks, and most engineering uses.

This soil is well suited to all crops commonly grown in the county. Water erosion is a hazard when this soil is cultivated. The main concerns of management are controlling erosion and maintaining fertility and soil tilth. Terraces and contour farming help control erosion. Returning crop residue to the soil helps increase water intake and maintain tilth and organic-matter content.

This unit is also well suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by low strength. Using properly designed and reinforced foundations helps prevent structural damage. This soil is also moderately limited for local roads and streets by low strength. This limitation can be lessened by strengthening or replacing the base material. This soil has slight limitations for septic tank absorption fields. Seepage is a moderate limitation for sewage lagoons.

This soil is in capability subclass IIIe.

Mg—Minco silt loam, 7 to 15 percent slopes. This deep soil is strongly sloping and well drained. It is on short, steep side slopes in uplands and is along the Arkansas River. Individual areas are narrow and continuous and range from 40 to 150 acres.

Typically, the surface layer is brown silt loam about 15 inches thick. The subsoil, about 27 inches thick, is brown, friable silt loam. The substratum, to a depth of about 60 inches, is yellowish red silt loam. In some places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Attica and Vanoss soils and a few limestone outcrops.

Vanoss soils have a more clayey subsoil than the Minco soil. Attica soils have a fine sandy loam subsoil. The landscape position of the Attica soils is similar to that of the Minco soil. Limestone outcrops are near the ridgetops. The included soils make up 15 percent of the unit.

The surface layer is friable and has good tilth. Permeability is moderate, available water capacity is high, and surface runoff is rapid. Natural fertility is medium, and organic-matter content is moderate. Reaction is medium acid to neutral in the surface layer and is slightly acid to neutral in the subsoil. Shrink-swell potential is low.

Most of the acreage of this soil remains in native grass and is used for grazing. Potential of this soil is poor for crops. It is good for rangeland, pasture, openland wildlife habitat, and windbreaks. It is fair for most engineering uses.

This unit is best suited to rangeland. The major problem of range management is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by low strength and slope. Using properly designed and reinforced foundations helps prevent structural damage. This soil is also moderately limited for local roads and streets by low strength. This limitation can be lessened by strengthening or replacing the base material. This soil is moderately limited for septic tank absorption fields and sewage lagoons by slope. Septic tank absorption fields generally can be located in less sloping areas.

This soil is in capability subclass VIe.

Na—Norge silt loam, 1 to 3 percent slopes. This deep soil is gently sloping and well drained. It is on side slopes in uplands. Individual areas of this unit are irregular in shape and range from 30 to 80 acres in size.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The subsoil to a depth of 60 inches is reddish brown silty clay loam. The upper part is friable, and the lower part is firm. In some places the surface layer is silty clay loam or loam. In other places the subsoil is sandy clay loam.

Included with this soil in mapping are small areas of Smolan and Minco soils. The landscape position of the included soils is similar to that of the Norge soil. Smolan soils have a more clayey subsoil, and Minco soils have a silt loam subsoil. The included soils make up about 15 percent of the unit.

The surface layer is friable and easily tilled. Permeability is moderately slow, available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction is slightly acid or medium acid in the surface layer and is slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of the soil is good for crops, rangeland, openland wildlife habitat, pasture, and windbreaks. It is good for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Water erosion is a hazard if the soils are cultivated but unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth. This soil can be readily leveled for irrigation if adequate water is available.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placed salt and water to distribute cattle help improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength is a severe limitation for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by moderately slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil has a moderate limitation for sewage lagoons because of the slope. Sewage lagoons can generally be located in less sloping areas.

The soil is in capability subclass IIe.

Nb—Norge silt loam, 3 to 7 percent slopes. This deep soil is moderately sloping and well drained. It is on side slopes along drainageways in uplands. Individual areas of this unit are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil, to a depth of 60 inches, is reddish brown, silty clay loam. The upper part is friable, and the lower part is firm. In some places the surface layer is silty clay loam or loam. In other places

the subsoil is sandy clay loam. In small areas, this soil is severely eroded.

Included with this soil in mapping are small areas of Smolan and Minco soils. The landscape position of the included soils is similar to that of the Norge soil. Smolan soils have a more clayey subsoil, and Vanoss soils have a silt loam subsoil. The included soils make up about 15 percent of the unit.

The surface layer is friable and easily tilled. Permeability is moderate slow, available water capacity is high, and surface runoff is rapid. Natural fertility is medium, and organic-matter content is moderate. Reaction is slightly acid or medium acid in the surface layer and slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of this soil is good for crops, rangeland, pasture, windbreaks, openland wildlife habitat, and for most engineering uses.

This soil is suited to most crops commonly grown in the county. Water erosion is a hazard when the soil is cultivated but unprotected. The main concerns of management are controlling erosion and maintaining tilth and fertility. Terraces and contour farming are needed to help control erosion. Minimum tillage, returning crop residue to the soil, and use of fertilizer help conserve moisture and maintain organic-matter content, fertility, and tilth.

This soil is also well suited to rangeland. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses and conserve moisture. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by low strength and shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength is a severe limitation for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by moderately slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. Slope is a moderate limitation for sewage lagoons, but sewage lagoons can generally be located in less sloping areas.

This soil is in capability subclass IIIe.

Nc—Norge silty clay loam, 3 to 7 percent slopes, eroded. This deep soil is moderately sloping and well drained. It is on side slopes along drainageways in uplands. Rills are common, and gullies are in some places. Individual areas of this unit range from 30 to 100 acres.

Typically the surface is dark brown silty clay loam about 6 inches thick. Part of the original surface layer has been removed by erosion, and material from the subsoil has been mixed into the remaining surface layer by plowing. The subsoil, to a depth of 60 inches, is reddish brown, firm silty clay loam. In some places the surface layer is silt loam or loam. In other places the lower part of the subsoil is redder.

Included with this soil in mapping are small areas of Smolan and Minco soils. The landscape position of the included soils is similar to that of the Norge soil. Smolan soils have a more clayey subsoil, and Minco soils have a silt loam subsoil. The included soils make up about 15 percent of the unit.

The surface layer is firm and has poor tilth. Permeability is moderately slow, available water capacity is high, and surface runoff is rapid. Natural fertility is low, and organic-matter content is moderately low. Reaction is slightly acid or medium acid in the surface layer and is slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. A few areas have been abandoned or reseeded to native grasses. Potential of this soil is fair for crops. It is good for rangeland, pasture, windbreaks, openland wildlife habitat, and most engineering uses.

This soil is moderately well suited to most crops commonly grown in the county. Continued erosion is a hazard when this soil is cultivated. The main concerns of management are controlling erosion and maintaining fertility and soil tilth. Terraces and contour farming help control water erosion. Returning crop residue to the soil and using fertilizer help conserve moisture and maintain organic matter, fertility, and tilth.

This soil is moderately well suited to rangeland. The major concern of range management is erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetation cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help to keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by low strength and shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of

the soil. Low strength is a severe limitation for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by moderately slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope but sewage lagoons can generally be located in the less sloping areas.

This soil is in capability subclass IVe.

Oa—Olpe gravelly silt loam, 2 to 12 percent slopes. This deep soil is gently sloping to strongly sloping and well drained. It is on rolling hills in uplands. Individual areas of this unit are irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is about 16 inches thick. The upper part is dark grayish brown, gravelly silt loam. The lower part is brown, gravelly silty clay loam. The subsoil extends to a depth of 60 inches. The upper part is reddish brown, firm gravelly silty clay loam. The middle part is reddish brown and yellowish red, very firm gravelly silty clay. The lower part is coarsely mottled yellowish red and light yellowish gray, very firm gravelly silty clay. In some places the surface layer is silt loam or gravelly silty clay loam.

Included with this soil in mapping are small areas of Norge and Smolan soils. Norge and Smolan soils are on foot slopes of the hills. They do not have gravel throughout the subsoil as the Olpe soil does. The included soils make up about 15 percent of the map unit.

Permeability is slow, available water capacity is moderate, and surface runoff is medium. Tilth is poor, because the surface layer contains gravel. Natural fertility is medium, and organic-matter content is moderate. Reaction is slightly acid or medium acid in the surface layer and ranges from slightly acid to mildly alkaline in the subsoil. Shrink-swell potential is moderate.

Most of this soil is used for rangeland; potential of the soil is poor for crops and windbreaks. It is good for rangeland, pasture, and openland wildlife habitat. It is good to fair for most engineering uses.

This unit is best suited to rangeland. The major concern of range management is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is poorly suited to trees grown as windbreaks and environmental plantings. Planting is sometimes difficult because of gravel in the soil. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil is moderately limited for local roads and streets by shrink-swell potential. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeabiltiy. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is severely limited for sewage lagoons by small stones.

This soil is in capability subclass VIe.

Ob—Osage silty clay. This deep soil is nearly level and poorly drained. It is on flood plains and is occasionally flooded. This soil is in concave areas on low stream terraces. Individual areas are irregular in shape and range from 40 to 150 acres in size.

Typically, the surface layer is dark gray silty clay about 18 inches thick. The lower part contains very dark gray mottles. The subsoil is extremely firm silty clay that extends to a depth of 60 inches. The upper part is very dark gray and is mottled with dark grayish brown. The lower part is gray and is mottled with dark brown and olive brown.

Included with this soil in mapping are small areas of Brewer and Verdigris soils. They are in higher positions on the landscape. Brewer soils have a less clayey subsoil, and Verdigris soils are silt loam throughout. The included soils make up about 10 percent of the map unit.

The surface layer is firm and has poor tilth. The surface layer and subsoil have prominent cracks during dry seasons. Permeability and surface runoff are very slow, and available water capacity is moderate. A seasonal high water table fluctuates between the surface and 1 foot in depth. Natural fertility is high, and organic-matter content is moderate. Reaction ranges from medium acid to neutral in the surface layer and ranges from medium acid to mildly alkaline in the subsoil. The shrink-swell potential is very high.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of the soil is fair for crops; openland, woodland, and wetland wildlife habitat; and windbreaks. It is good for rangeland and pasture. It is poor for most engineering uses.

This soil is moderately well suited to small grain, soybeans, sorghum, and alfalfa. The hazard of flooding and the very slow permeability limit the choice of crops and the timeliness of tillage. Tillage that is performed when the soil is too wet or too dry causes the soil to be cloddy. Minimum tillage performed at optimum moisture conditions and returning crop residue to the soil help to maintain tilth, content of organic matter, and fertility.

This soil is well suited to rangeland. It receives extra moisture as runoff from nearby higher soils and from flooding. Grazing when the soil is too wet causes compaction of the surface and poor tilth. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placing of salt and water to distribute cattle improve range condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings and local roads and streets by flooding, wetness, and very high shrink-swell potential. If buildings and roads are constructed on these soils, flood protection is needed. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage to buildings caused by shrinking and swelling of the soil. When building roads, the base material needs to be strengthened or replaced. This soil is severely limited for septic tank absorption fields by very slow permeability, flooding, and wetness. This soil has slight limitations for sewage lagoons if it is protected from flooding.

This soil is in capability subclass IIIw.

Ra—Reading silt loam. This deep soil is nearly level and well drained. This soil is on stream terraces along Grouse and Silver Creeks. It is in broad areas parallel to the stream channel and is rarely flooded. Individual areas range from 50 to 300 acres.

Typically, the surface layer is dark grayish brown silt loam about 14 inches thick. The subsoil is about 36 inches thick. The upper part is dark brown, friable silty clay loam. The lower part is brown, firm silty clay loam. The substratum, to a depth of about 60 inches, is yellowish brown silty clay loam.

Included with this soil in mapping are small areas of Brewer, Ivan, and Martin soils. Brewer and Martin soils have a more clayey subsoil than the Reading soil. Brewer soils are in slight depressions, and Martin soils are adjacent to the uplands. Ivan soils have a less clayey subsoil than this Reading soil, and they are near the stream channel. The included soils make up about 15 percent of the map unit.

The surface layer is friable and easily tilled. Permeability is moderately slow, available water capacity is high, and surface runoff is slow. The natural fertility is high, and organic-matter content is moderate. Reaction is slightly acid or medium acid in the surface layer and subsoil. Shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, alfalfa, and soybeans. Potential of this soil is good for crops; rangeland; pasture; windbreaks; and openland, rangeland, and woodland wildlife habitat. It is fair for most engineering uses.

This soil is well suited to small grain, sorghum, soybeans, and alfalfa (fig. 11). The main concerns of management are maintaining fertility, tilth, and organic matter content. Returning crop residue to the soil and minimum tillage help maintain fertility, tilth, and organic-matter content and conserve moisture. There is little or no erosion hazard.

This soil is well suited to rangeland. It receives extra moisture as runoff from adjacent upland soils. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle help improve range.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings unless it is protected from flooding. Even if the soil is protected from flooding, shrink-swell potential is a moderate limitation for buildings. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength is a severe limitation for local roads and streets. It can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by moderately slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by seepage.

This soil is in capability class I.

Rb—Rosehill silty clay, 1 to 3 percent slopes. This moderately deep soil is gently sloping and well drained. It is in small, irregularly shaped areas near drainageways and on convex ridgetops in uplands. Individual areas range from 20 to 100 acres.

Typically, the surface layer is dark grayish brown silty clay about 8 inches thick. The subsoil is about 12 inches thick. The upper part is dark grayish brown firm silty clay, and the lower part is grayish brown, extremely firm silty clay that has some dark grayish brown streaks. The substratum is multicolored clay that contains a few fragments of soft shale. Clayey shales are at a depth of 37 inches. In some places the depth to shale is less than 20 inches.

Included with this soil in mapping are small areas of Irwin and Tabler soils. Irwin and Tabler soils are more than 60 inches deep. The landscape position of the included soils is similar to that of the Rosehill soil. The included soils make up about 10 percent of the map unit.

The surface layer is firm and has poor tilth. Permeability is very slow, and surface runoff is medium. Available water capacity is low, and the organic-matter content is moderate. Natural fertility is medium, and reaction ranges from slightly acid to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to shale ranges from 20 to 40 inches.

Most areas of this soil are cultivated. Potential of this soil is fair for crops and openland and rangeland wildlife habitat. It is good for rangeland, pasture, and windbreaks. It is poor for most engineering uses.

This soil is suited to most crops commonly grown in the county. The yields of alfalfa and other crops that mature in summer are lower because available water capacity is low. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terraces and contour farming help control erosion. Returning crop residue to the soil and use of fertilizer help maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Major concerns of range management are the hazard of erosion and the low available water capacity. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength is a severe limitation for local roads and streets. This limitation can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by very slow permeability and depth to bedrock. It has moderate limitations for sewage lagoons because of depth to bedrock and slope. Sewage lagoons can generally be located on the less sloping, deeper included soils.

This soil is in capability subclass IIIe.

Rc—Rosehill silty clay, 3 to 6 percent slopes. This moderately deep soil is moderately sloping and well drained. It is on side slopes of ridgetops and is near drainageways in uplands. Areas are small and irregular in shape and range from about 20 to 80 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 8 inches thick. The subsoil is about 12 inches thick. The upper part is dark grayish brown, firm silty clay, and the lower part is grayish brown, extremely firm silty clay that has some dark grayish brown streaks. The substratum is multicolored clay that contains a few fragments of soft shale. Clayey shales are at a depth of 37 inches. In some places the depth to shale is less than 20 inches.

Included with this soil in mapping are small areas of Irwin and Labette soils. Irwin soils are more than 60 inches deep. In Labette soils limestone is at depths of 20 to 40 inches. The landscape position of the included soils is similar to that of the Rosehill soil. The included soils make up about 10 percent of the map unit.

The surface layer is firm and has poor tilth. Permeability is very slow, and surface runoff is medium. Available water capacity is low, and the organic-matter content is moderate. The natural fertility is medium, and reaction ranges from slightly acid to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to shale ranges from 20 to 40 inches.

Most areas of this soil are cultivated. The potential of the soil is fair for crops and openland and rangeland wildlife habitat. It is good for rangeland, pasture, and windbreaks. It is poor for most engineering uses.

The soil is suited to most crops commonly grown in the county. The yields of alfalfa and other crops that mature in the summer are lower because available water capacity is low. The main concerns of management are controlling erosion, conserving moisture, and maintaining soil tilth. Terraces and contour farming help control erosion. Returning crop residue to the soil and using fertilizer help maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Major concerns of range management are the hazard of erosion and the low available water capacity. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil is severely limited for local roads and streets by low strength. This limitation can be les-

sened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by very slow permeability and depth to bedrock. It has moderate limitations for sewage lagoons because of depth to bedrock and slope. Sewage lagoons can generally be located on the less sloping, deeper included soils.

This soil is in capability subclass IIIe.

Sa—Smolan silty clay loam, 1 to 3 percent slopes. This deep soil is gently sloping and well drained. It is on foot slopes in uplands. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 8 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, very firm silty clay that has a few small black concretions. The lower part is reddish brown extremely firm silty clay that has a few small black concretions and lime concretions. The substratum, to a depth of about 60 inches, is reddish brown, silty clay loam. In some places the subsoil is browner. In other places the subsoil is mottled with gray.

Included with this soil in mapping are small areas of Labette and Norge soils. In Labette soils limestone is at depths of 20 to 40 inches. Labette soils are on the lower side slopes. Norge soils have a less clayey subsoil than this Smolan soil. The landscape position of the Norge soils is similar to that of the Smolan soil. The included soils make up about 10 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is slow, available water capacity is high, and surface runoff is medium. Natural fertility is medium, and organic-matter content is moderate. Reaction ranges from medium acid to neutral in the surface layer and upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. Shrink-swell potential is high.

Most areas of this soil are used for wheat, sorghum, and alfalfa. The potential of the soil is good for crops, rangeland, pasture, windbreaks, and openland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Water erosion is a hazard if the soils are cultivated but unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. The use of soil for local roads and streets is severely limited by low strength and high shrink-swell potential. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. Increasing the size of the absorption field improves the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope; however, sewage lagoons can generally be located in the less sloping areas.

This soil is in capability subclass IIe.

Sb—Smolan silty clay loam, 3 to 7 percent slopes. This deep soil is moderately sloping and well drained. It is on side slopes along drainageways in the uplands. Individual areas are irregular in shape and range from 20 to 80 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 7 inches thick. The subsoil is about 30 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, very firm silty clay that has a few small black concretions. The lower part is reddish brown, extremely firm silty clay that has a few small black concretions and lime concretions. The substratum, to a depth of about 60 inches, is reddish brown silty clay loam. In some places the subsoil is browner. Also in small areas this soil is severely eroded.

Included with this soil in mapping are small areas of Norge and Martin soils. Norge soils have a less clayey subsoil than the Smolan soil. In Martin soils the lower part of the subsoil is mottled and less red. The landscape position of the included soils is similar to that of the Smolan soil. The included soils make up about 10 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is slow, available water capacity is high, and surface runoff is rapid. Natural fertility is medium, and organic-matter content is moderate. Reaction ranges from medium acid to neutral in the surface layer and upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. Shrink-swell potential is high.

About 80 percent of this soil is used for wheat, sorghum, and alfalfa. The remainder is in native grass and used for grazing. Potential of the soil is good for crops, rangeland, pasture, windbreaks, and openland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to most crops commonly grown in the county. Water erosion is a hazard when the soil is cultivated but unprotected. The main concerns of management are controlling erosion and maintaining tilth and fertility. Terraces and contour farming help control erosion. Minimum tillage, returning crop residue to the soil,

and use of fertilizer help conserve moisture and maintain organic matter, fertility, and tilth.

This soil is also well suited to rangeland. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses and conserve moisture. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil is severely limited for local roads and streets by low strength and high shrink-swell potential. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope; however, sewage lagoons can generally be located in the less sloping areas.

This soil is in capability subclass IIIe.

Sc—Smolan silty clay loam, 3 to 7 percent slopes, eroded. This deep soil is moderately sloping and well drained. It is on side slopes along drainageways in uplands. Rills are common, and gullies are in some places. Individual areas are irregular in shape and range from 20 to 60 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 6 inches thick. Part of the original surface layer has been removed by erosion, and material from the subsoil has been mixed into the remaining surface layer by plowing. The subsoil is about 27 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, very firm silty clay that has a few small black concretions. The lower part is reddish brown, extremely firm silty clay that has a few small black concretions and lime concretions. The substratum, to a depth of about 60 inches, is reddish brown silty clay loam. In some places the subsoil is mottled with gray. In other places the surface layer is brown silty clay. On some of the lower side slopes, the surface layer is thicker.

Included with this soil in mapping are small areas of Norge and Martin soils. Norge soils have a less clayey subsoil. In Martin soils the lower part of the subsoil is mottled and less red. The landscape position of the included soils is similar to that of the Smolan soil. The included soils make up about 10 percent of the map unit.

The surface layer is firm and has poor tilth. Permeability is slow, available water capacity is high, and surface runoff is rapid. Natural fertility is medium, and organic-matter content is moderately low. Reaction ranges from medium acid to neutral in the surface layer and upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. Shrink-swell potential is high.

Most of the areas of this soil are used for wheat and sorghum. A few areas have been abandoned or have been reseeded to native grasses. Potential of this soil is fair for crops. It is good for range, pasture, windbreaks, and openland wildlife habitat. It is poor for most engineering uses.

The soil is moderately well suited to most crops commonly grown in the county. Continued erosion is a hazard when this soil is cultivated. The main concerns of management are controlling erosion and maintaining fertility and soil tilth. Terracing and contour farming help control water erosion. Returning crop residue to the soil and using fertilizer help conserve moisture and maintain organic-matter, fertility, and tilth.

This soil is well suited to rangeland. Major concerns of range management are past erosion and the hazard of further erosion. Management that maintains adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help to keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil is severely limited for local roads and streets by low strength and shrink-swell potential. These limitations can be lessened by strengthening or replacing the base material. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field helps improve the function of the septic tank system. This soil is moderately limited for sewage lagoons by slope; however, sewage lagoons can generally be located in the less sloping areas.

This soil is in capability subclass IVe.

Sd—Sogn silty clay loam, 0 to 10 percent slopes. This shallow soil is nearly level to strongly sloping and somewhat excessively drained. It is on narrow divides

and side slopes of ridgetops in uplands. Individual areas are irregular in shape and range from 20 to 150 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. It is over level-bedded limestone. In some places the surface layer contains platy fragments of limestone. In some places the surface layer is silt loam or loam. In other places limestone rock or shale is exposed at the surface.

Included with this soil in mapping are small areas of Clime and Labette soils. Clime soils are 20 to 40 inches deep to shale, and Labette soils are 20 to 40 inches deep to limestone. The landscape position of the included soils is similar to that of the Sogn soil. The included soils make up 10 percent of the map unit.

Permeability is moderate, available water capacity is very low, and surface runoff is medium. Natural fertility is medium and organic-matter content is moderately low. Reaction ranges from slightly acid to moderately alkaline. The root zone extends to limestone bedrock. Shrink-swell potential is moderate.

All areas of this soil remain in native grass and are used for grazing. Potential is fair for rangeland. It is poor for cropland; pasture; windbreaks; openland, wetland, and rangeland wildlife habitat; and most engineering uses.

This map unit is best suited to rangeland. Major concerns of range management are the hazard of erosion and the very low available water capacity. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses by reducing runoff. This also improves the moisture supplying capacity. Overstocking and overgrazing the range reduce the protective vegetative cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by the less productive short grasses. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is poorly suited to trees grown as windbreaks and environmental plantings, because depth to bedrock is shallow.

This soil is severely limited for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons by shallow depth to bedrock.

This soil is in capability class VIIs.

Ta—Tabler silty clay loam, 0 to 1 percent slopes. This deep soil is nearly level and moderately well drained. It is in broad, smooth to slightly concave areas on high terraces and uplands. Individual areas range from 20 acres to several hundred acres.

Typically, the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark gray, the middle part is gray with faint brown mottles, and the lower part is grayish brown with faint brown and very dark gray mottles. The substratum, to a depth of about 60 inches, is light brownish gray silty clay that has strong brown mottles. In some places this soil has a surface layer that is more than 14 inches thick or a subsurface layer that is light gray silt loam.

Included with this soil in mapping are small areas of Vanoss soils. The well drained Vanoss soil is on small ridges. This included soil makes up about 5 percent of the unit.

The surface layer is friable and has fair tilth. Permeability is very slow, and surface runoff is slow. The available water capacity is high. The organic-matter content is moderate, and the natural fertility is medium. Reaction is slightly acid or neutral in the surface layer and is neutral to moderately alkaline in the subsoil. Shrink-swell potential is high.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of this soil is good for crops, rangeland, pasture, and openland wildlife habitat. It is fair for windbreaks. It is poor for engineering areas.

This soil is well suited to small grain, sorghum, and alfalfa. The main concerns of management are maintaining soil tilth, organic-matter content, and fertility. Minimum tillage, returning crop residue to the soil, and use of fertilizer help conserve moisture and maintain organic-matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help keep the range and soil in good condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and high shrink-swell potential are also severe limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by very slow permeability and wetness. It is suited to sewage lagoons.

The soil is in capability subclass IIs.

Tb—Tabler silty clay loam, 1 to 3 percent slopes. This deep soil is gently sloping and moderately well drained. It is on broad, smooth ridgetops in uplands. Individual areas are irregular in shape and range from about 20 to 100 acres in size.

Typically, the surface layer is dark gray silty clay loam about 7 inches thick. The subsoil is very firm silty clay

about 40 inches thick. The upper part is dark gray, the middle part is gray with faint, brown mottles, and the lower part is grayish brown and has faint brown and very dark gray mottles. The substratum, to a depth of about 60 inches, is light brownish gray silty clay that is mottled with strong brown. In some places the subsoil is brown. In other places the surface layer is more than 14 inches thick.

The surface layer is friable and has fair tilth. Permeability is very slow, and runoff is medium. Available water capacity is high, the organic-matter content is moderate, and the fertility is medium. Reaction is slightly acid or neutral in the surface layer and neutral to moderately alkaline in the subsoil. Shrink-swell potential is high.

Most areas of this soil are used for wheat and sorghum. Potential of the soil is good for crops, rangeland, pasture, and openland wildlife habitat. It is fair for windbreaks. It is poor for most engineering uses.

This soil is well suited to small grain, sorghum, and alfalfa. Water erosion is a hazard if the soil is cultivated but unprotected. Terraces and contour farming help control erosion. Proper use of fertilizer and returning crop residue to the soil help to maintain fertility, organic-matter content, and tilth.

This soil is well suited to rangeland. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help keep the range and soil in good condition.

This soil is moderately well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and high shrink-swell potential are severe limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by very slow permeability and wetness. It is moderately limited for sewage lagoons by slope. Sewage lagoons can generally be located in less sloping areas.

This soil is in capability subclass IIIe.

Va—Vanoss silt loam, 0 to 1 percent slopes. This deep soil is nearly level and well drained. It is in small, irregularly shaped areas on high terraces and broad, upland ridges. Individual areas range from 15 acres to several hundred acres.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil extends to a depth of 60 inches or more. It is brown, friable silty clay loam in the upper part, and brown, mottled friable silt loam in the lower part. In some places the surface layer is thicker, or the subsoil is more clayey.

Included with this soil in mapping are small areas of Tabler soils. These soils are darker colored and more clayey than this Vanoss soil. They are in small depressional areas. The Tabler soils make up about 5 percent of the unit.

The surface is friable and easily tilled. Permeability is moderate, and runoff is slow. The available water capacity is high. Reaction is slightly acid or medium acid in the surface layer and upper part of the subsoil and is slightly acid to neutral in the lower part of the subsoil. The shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of this soil is good for crops, rangeland, pasture, windbreaks, openland and rangeland wildlife habitat, and most engineering uses.

This soil is well suited to all crops commonly grown in the county. The main concerns of management are maintaining soil tilth, organic-matter content, and fertility. Minimum tillage, returning crop residue to the soil, and use of fertilizer help conserve moisture and maintain organic-matter content, fertility, and tilth. This soil is well suited to irrigation.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and shrink-swell potential are moderate limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil has slight limitations for septic tank absorption fields. It is moderately limited for sewage lagoons by seepage. Sealing the lagoon reduces seepage.

This soil is in capability class I.

Vb—Vanoss silt loam, 1 to 3 percent slopes. This deep soil is gently sloping and well drained. It is on narrow ridgetops in uplands. Individual areas are irregular in shape and range from 20 acres to several hundred acres in size.

Typically, the surface layer is brown silt loam about 12 inches thick. The subsoil extends to a depth of 60 inches

or more. It is brown, friable silty clay loam in the upper part and brown, mottled, friable silt loam in the lower part. In some places the subsoil is more clayey. In other places it is redder.

Included with this soil in mapping are small areas of Minco soils. The Minco soils have a less clayey subsoil than the Vanoss soil. The landscape position of the included soils is similar to that of the Vanoss soil. The included soils make up 5 percent of the unit.

Permeability is moderate, and runoff is medium. The available water capacity is high, organic-matter content is moderate, and the natural fertility is high. The surface layer is friable and easily tilled. Reaction is slightly acid or medium acid in the surface layer and the upper part of the subsoil and is slightly acid to neutral in the lower part of the subsoil. The shrink-swell potential is moderate.

Most areas of this soil are used for wheat, sorghum, and alfalfa. Potential of the soil is good for crops, rangeland pasture, windbreaks, openland and rangeland wildlife habitat, and most engineering uses.

This soil is well suited to all crops commonly grown in the county. Water erosion is a hazard where the soil is cultivated but unprotected. Terraces and contour farming help control erosion. Minimum tillage, returning crop residue to the soil, and use of fertilizer help conserve moisture and maintain organic-matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and shrink-swell potential are moderate limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil has slight limitations for septic tank absorption fields. It is moderately limited for sewage lagoons by seepage and slope. Sealing the lagoon reduces seepage.

This soil is in capability subclass IIe.

Vc—Vanoss silt loam, 3 to 7 percent slopes. This deep soil is moderately sloping and well drained. It is on side slopes along drainageways in the uplands. Individual areas are irregular in shape and range from 40 to 200 acres in size.

Typically the surface layer is brown silt loam about 10 inches thick. The subsoil extends to a depth of 60 inches. It is brown, friable silty clay loam in the upper part and brown, mottled friable silt loam in the lower part. In some places the subsoil is redder. In small areas this soil is severely eroded.

Included with this soil in mapping are areas of Minco soils. The Minco soil has a less clayey subsoil than this Vanoss soil. The landscape position of the included soils is similar to that of the Vanoss soil. The included soils make up 5 to 10 percent of the unit.

The surface layer is friable and easily tilled. Permeability is moderate, and runoff is medium. Available water capacity is high, organic-matter content is moderate, and natural fertility is high. Reaction is slightly acid or medium acid in the surface layer and upper part of the subsoil and is slightly acid to neutral in the lower part. The shrink-swell potential is moderate.

Most areas of this soil are used for wheat and sorghum. Potential of the soil is good for crops, rangeland, pasture, windbreaks, openland and rangeland wildlife habitat, and most engineering uses.

This soil is well suited to most crops commonly grown in the county. Water erosion is a hazard when the soil is cultivated but unprotected. The main concerns of management are controlling erosion and maintenance of tilth and fertility. Terraces and contour farming help control erosion. Minimum tillage, returning crop residue to the soil, and use of fertilizer help conserve moisture and maintain organic-matter content, fertility, and tilth.

This soil is well suited to rangeland. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses and conserves moisture. Proper stocking rates, uniform grazing distribution, and timely deferment of grazing help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is moderately limited for dwellings by shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. Low strength and shrink-swell potential are moderate limitations for local roads and streets. These limitations can be lessened by strengthening or replacing the base material. This soil has slight limitations for septic tank absorption fields. It is moderately limited for sewage lagoons by seepage and slope. Sealing the lagoon helps reduce seepage.

This soil is in capability subclass IIIe.

Vd—Verdigris silt loam. This deep soil is nearly level and moderately well drained. The soil is on low terraces

along streams and on flood plains (fig: 12). It is also in long, narrow areas of upland drainageways. Individual areas of this soil range from 20 to 300 acres in size. This soil is occasionally flooded.

Typically, the surface layer is silt loam about 29 inches thick. The upper part is grayish brown, the middle part is dark gray, and the lower part is grayish brown. The next layer, about 9 inches thick, is brown, friable silt loam that has a few strong brown mottles. The substratum, to a depth of about 60 inches, is brown silty clay loam that has a few strong brown mottles. In some places the surface layer is silty clay loam. In other places, along upland drainageways, fragments of limestone and shales are throughout the surface layer.

Included with this soil in mapping are small areas of Brewer soils. Brewer soils have a clayey subsoil, and are in slightly depressional areas. They make up about 15 percent of the map unit.

The surface layer is friable and has good tilth. Permeability is moderate, available water capacity is high, and surface runoff is slow. The natural fertility is high, and organic-matter content is moderate. Reaction is medium acid. Shrink-swell potential is moderate.

About 90 percent of the acreage of this soil is used for wheat, sorghum, alfalfa, and soybeans. The remainder is rangeland or is used for trees. Potential of the soil is good for crops; rangeland; pasture; windbreaks; and openland, woodland, and rangeland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to small grain, sorghum, soybeans, and alfalfa. Soil scouring and damage to crops are hazards because of occasional flooding. Management is needed mainly to control scouring, limit flood damage to crops, and to maintain organic-matter content and fertility. Returning crop residue to the soil and minimum tillage help to maintain fertility and tilth.

This soil is well suited to rangeland. It receives extra moisture as runoff from adjacent upland soils or from flooding. Overgrazing reduces the vigor and growth of the tall grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and properly placing salt and water to distribute cattle improve range condition.

This soil is well suited to trees grown as windbreaks and environmental plantings (fig. 13). Planting suitable species, preparing the site to control competing vegetation, and protecting the site from erosion, livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets by the hazard of flooding. Constructing dikes and levees helps lessen the hazard of flooding. The soil is a good source for topsoil.

This soil is in capability subclass IIw.

Wa—Waurika silt loam. This deep soil is nearly level and somewhat poorly drained. It is in depressions in the uplands. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is gray silt loam about 10 inches thick. The subsurface layer is gray silt loam about 2 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is dark gray, very firm silty clay that has some black concretions. The lower part is gray, firm silty clay loam that has strong brown mottles. It is calcareous and contains a few lime concretions. In some places there is no subsurface layer.

The surface layer is friable and has fair tilth. Permeability is very slow, and runoff is slow. Available water capacity is moderate, natural fertility is medium, and organic-matter content is moderately low. Reaction ranges from medium acid to neutral in the surface layer and is neutral to moderately alkaline in the subsoil. Shrink-swell potential is high. The seasonal high water table is at depths of 1 to 2 feet during the spring.

Most areas of this soil are used for wheat and sorghum. Potential of the soil is good for crops, rangeland, pasture, and windbreaks. It is fair for openland, wetland and rangeland wildlife habitat. It is poor for most engineering uses.

This soil is well suited to most crops commonly grown in the county. During wet weather, water is sometimes ponded on the surface and remains for several days. Planting and harvesting are often delayed. Crops are sometimes drowned. The main concerns of management are surface drainage and maintaining soil tilth, organic-matter content, and fertility. Installing drainage ditches improves surface drainage. Minimum tillage, returning crop residue to the soil, and use of fertilizer help maintain organic-matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing or grazing when the soil is too wet causes surface compaction. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and restricted use during wet periods help keep the range and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Planting suitable species, preparing the site to control competing vegetation, and protecting the site from livestock, fire, and rodents are necessary for success.

This soil is severely limited for dwellings by high shrink-swell potential, wetness, and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil. This soil is severely limited for local roads and streets by low strength and high shrink-swell potential. These limitations can be lessened by strengthening or replacing the base material. This soil is severely limited for septic tank absorption fields by slow permeability and wetness. It is suited to sewage lagoons.

This soil is in capability subclass IIw.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, assisted in preparing this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Approximately one-third of the acreage in Cowley County was used for crops in 1967 according to the Kansas Conservation Needs Inventory. From 1965 to 1975, wheat was produced on approximately 60 percent of the cropland. Sorghum was produced on approximately 60 percent of the cropland. Sorghum was produced on 13 percent of the cropland, alfalfa on 10 percent, and barley on 7 percent. Soybeans, corn, oats, and rye are minor crops in the county (*6*).

The acreage of wheat has increased by 25 percent over the past 10 years compared to the previous 10 years. During the same period, the acreage of soybeans has increased by 20 percent and that of alfalfa has remained constant. The acreage of all other crops has dropped.

Soil erosion is the major problem on about 75 percent of the cropland in Cowley County. Where the slope is more than 1 percent, erosion is a hazard. Bethany, Dale, Irwin, Labette, Martin, Norge, Tabler, and Vanoss soils are the principal soils used for cultivated crops in the county.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Bethany, Irwin, Labette, Martin, and Smolan soils. Second, soil erosion results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water.

Erosion control provides protective surface cover, which reduces runoff and increases infiltration. A cropping system that keeps plant cover on the soil for extended periods reduces soil erosion and preserves the productive capacity of the soils.

Terraces and diversion reduce the length of slopes and reduce runoff and erosion. They are most practical on deep, well drained soils that have uniform and regular slopes.

Contour tillage should generally be used in combination with terraces. Contour tillage and terracing are better suited to those soils that have smooth, uniform slopes.

Leaving crop residue on the surface, either by minimum tillage or stubble mulching, increases infiltration and reduces runoff and the hazard of water erosion. The extra cover is essential to help prevent wind erosion. These practices are becoming more common in Cowley County.

Information on erosion control is available in the Soil Conservation Service Service county offices. The latest information and suggestions for growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly cor-

rected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

Leonard J. Jurgens, range conservationist, Soil Conservation Service, assisted with this section.

Cowley County rangeland is in the southern part of the Bluestem Hills Resource Region. The Kansas Flint Hills are within this region and extend into the northeastern and part of the county. Approximately 397,000 acres of rangeland, which is about 55 percent of the total land area in the county, is used primarily for cattle grazing. Cow-calf enterprises dominate, but a large number of stocker-feeder and yearling operations also depend on this rangeland.

If properly managed, nearly all the soils in the county have excellent potential for producing a very high percentage of quality forage plants for grazing animals and rangeland wildlife. The unique combination of soils, climate, and topography present in Cowley County make these rangelands a natural resource that responds readily and rapidly to well planned grazing management.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each soil that supports rangeland vegetation suitable for grazing, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community that is predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic vegetation of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

In Cowley County, management to restore the range to excellent condition is feasible. Management can restore the potential natural plant community to excellent range condition on most of the rangeland in the county. Some poor quality rangeland and fields of abandoned

crops being used as rangeland should be revegetated with the proper native species to restore the natural plant community. At the present time, only about 20 percent of the rangeland in the county is producing its potential. Less than 10 percent needs revegation, however; the remaining 70 percent needs grazing management and some supplemental practices to restore the native species to their production potential.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife (fig. 14).

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

Charles Cheek, civil engineer, Soil Conservation Service, assisted in preparing this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, and shrink-swell potential, are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons

between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading.

Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability,

erodibility, wetness, and suitability for permanent vegetation.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Cowley County has several attributes that enhance its potential for recreational use. It is located near a large urban population and is served by adequate transportation routes. Much of the landscape is diverse and rural in nature. Numerous lakes and ponds add to the esthetic quality of the county and appeal to water-oriented recreationists. Although several public and private recreational areas are in use at the present time, potential still exists for further development.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Species of wildlife within the county are numerous because of the diverse number of habitat types. Openland, woodland, and rangeland habitat are dominant. These habitat types are interspersed throughout the county.

Furbearers are common along the streams and rivers that intersect the county, and trapping is done on a limited basis.

Bobwhite quail, prairie chicken, ducks, fox squirrel, cottontail rabbit, and white-tailed deer are the primary game species.

River and stream fishing is good to fair on most of the perennial streams. Stockwater ponds and watershed lakes also provide some good fishing. Species common to the county are: largemouth bass; channel, bullhead, and flathead catfish; carp; crappie; bluegill; and sunfish.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, soybeans, wheat, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, bermudagrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, ragweed, prairieclover, wheatgrass, and grama.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, hickory, sycamore, walnut, pecan, hackberry, osageorange, dogwood, and blackberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, cotoneaster, fragrant sumac, and American plum.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are buckbrush, sumac, plum, and blackberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, saltgrass, cordgrass and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, thrushes, woodpeckers, squirrels, gray fox, raccoon, opossum and deer.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, white-tailed deer, desert mule deer, prairie chicken, meadowlark, killdeer, lark bunting, coyote, and jackrabbits.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 15. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of

excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particule-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, matrix colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil maps for detailed planning."

Attica series

The Attica series consists of deep soils that are well drained and have moderately rapid permeability. These soils are on uplands. They formed in loamy and sandy eolian deposits. Slope ranges from 3 to 6 percent.

Attica soils are commonly adjacent to Milan and Tivoli soils on the landscape. Milan soils have a fine-loamy control section. Tivoli soils have a sandy control section.

Typical pedon of Attica loamy fine sand, 3 to 6 percent slopes, 1,550 feet west and 250 feet south of the northeast corner of sec. 15, T. 34 S., R. 3 E.

A1—0 to 9 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; very weak fine granular structure; soft, very friable; many fine roots; slightly acid, clear smooth boundary.

B2—9 to 20 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable; few fine roots; slightly acid; gradual smooth boundary.

B3—20 to 36 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; massive; loose; few fine roots; slightly acid; gradual smooth boundary.

C—36 to 60 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; massive; loose; neutral.

The thickness of the solum ranges from about 28 to 50 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 2 or 3. It is dominantly loamy fine sand but ranges to fine sandy loam. Reaction ranges from medium acid to neutral. The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4. Reaction is medium acid or slightly acid. The B3 horizon has hue of 7.5YR to 10YR, value of 5 or 6 when dry and 4 or 5 moist, and chroma or 3 or 4. It is typically fine sandy loam, but it is less commonly loamy fine sand. The C horizon has colors similar to those of the B3 horizon. It is fine sandy loam or loamy fine sand. Reaction is slightly acid or neutral. Silty or clayey strata that do not conform are below depths of 40 inches in some pedons.

Bethany series

The Bethany series consists of deep soils that are well drained and slowly permeable. These soils are on uplands. They formed in old alluvium and loess. Slope ranges from 0 to 3 percent.

Bethany soils are similar to Brewer and Irwin soils and are commonly adjacent to Irwin, Tabler, Vanoss, and Waurika soils on the landscape. Brewer soils decrease significantly in clay content within 60 inches. Irwin and Tabler soils have a more abrupt textural change between the A and B horizons. Tabler soils are moderately well drained. Vanoss soils have a fine silty control section. Waurika soils have an A2 horizon.

Typical pedon of Bethany silt loam, 1 to 3 percent slopes, 1,520 feet south and 150 feet west of the northeast corner of sec. 33, T. 34 S., R. 3 E.

Ap—0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; soft, friable; few fine roots; slightly acid; gradual smooth boundary.

B1—9 to 16 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, friable; few fine roots; slightly acid, clear smooth boundary.

B21t—16 to 27 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thin continuous clay films on faces of peds; neutral; clear smooth boundary.

B22t—27 to 36 inches; grayish brown (10YR 5/2) silty clay, dark brown (10YR 3/3) moist; few fine faint brownish yellow (10YR 6/8) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces or peds; few small lime concretions; mildly alkaline; clear smooth boundary.

B3—36 to 60 inches; light brown (7.5YR 6/4) silty clay loam, dark brown (7.5YR 4/4) moist; common coarse distinct yellowish red (5YR 5/8) mottles; weak medium and coarse blocky structure; very hard, very firm; common small black concretions; moderately alkaline.

The thickness of the solum is more than 60 inches. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. Reaction ranges from medium acid to neutral. The B21t horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is silty clay loam, silty clay, or light clay. Reaction is neutral or mildly alkaline. The B22t horizon has hue of 7.5YR or 10YR; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 2, 3, or 4. It is silty clay or clay. Reaction is mildly alkaline or moderately alkaline. The B3 horizon typically has hue of 7.5YR or 10YR, but is 5YR in some pedons. Value is 4 or 5 when dry and 3 or 4 when moist; and chroma is 2 to 6. It contains common coarse yellowish red, yellowish brown, or reddish brown mottles. It is silty clay loam or clay. Reaction is mildly alkaline or moderately alkaline. The clay content of the Bt horizon ranges from 35 to 48 percent.

Brewer series

The Brewer series consists of deep soils that are moderately well drained and slowly permeable. These soils are on low terraces and flood plains. They formed in clayey alluvium. Slope ranges from 0 to 1 percent.

Brewer soils are similar to Bethany and Tabler soils and are commonly adjacent to Osage and Verdigris soils on the landscape. Bethany soils do not decrease significantly in clay content within 60 inches. Osage soils have vertic properties and lack an argillic horizon. Tabler soils have vertic properties. Verdigris soils do not have an argillic horizon and are less clayey than Brewer series.

Typical pedon of Brewer silty clay loam, 2,480 feet west and 100 feet north of the southeast corner of sec. 19, T. 30 S., R. 4 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

A12—7 to 15 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; few fine roots; slightly acid; gradual smooth boundary.

B21t—15 to 25 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, firm; few fine roots; neutral; gradual smooth boundary.

B22t—25 to 42 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; few faint strong brown (7.5YR 5/6) mottles in lower part; strong medium blocky structure; very hard, very firm; few fine roots; thick continuous clay films on faces of peds; mildly alkaline; gradual smooth boundary.

B3—42 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; common fine faint dark yellowish brown (10YR 4/4) mottles; weak coarse blocky structure; very hard, very firm; moderately alkaline.

The thickness of the solum ranges from 50 inches to more than 60 inches. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 10YR, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 1 or 2. Reaction is slightly acid or neutral. The B2t horizon has hue of 10YR, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is silty clay. Clay content of the B2t horizon averages between 40 to 45 percent. Reaction ranges from neutral to moderately alkaline. The B3 horizon has hue of 7.5YR or 10 YR, value of 3 to 5 when dry and 2 to 4 when moist, and chroma of 2 or 3. It contains common, fine, faint mottles that are dark yellowish brown or brownish yellow. Reaction ranges from neutral to moderately alkaline.

Canadian series

The Canadian series consists of deep soils that are well drained and have moderately rapid permeability. These soils are on low terraces and flood plains. They formed in loamy and sandy alluvium. Slope ranges from 0 to 1 percent.

Canadian soils are similar to Minco soils and are commonly adjacent to Dale, Lesho, and Lincoln soils on the landscape. Minco soils have a coarse silty control section. Dale soils have a fine-silty control section. Lesho soils have a finer textured A and B horizon than the Canadian soils, and these horizons are over sandy layers. Lincoln soils lack a mollic epipedon.

Typical pedon of Canadian fine sandy loam, 1,150 feet north and 75 feet west of the southeast corner of sec. 31, T. 32 S., R. 3 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; few fine roots; neutral; clear smooth boundary.

A12—7 to 16 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable; few fine roots, neutral; clear smooth boundary.

B2—16 to 28 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; soft, very friable; few fine roots; neutral; gradual wavy boundary.

C1—28 to 36 inches; yellowish brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak very fine granular structure; soft, very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—36 to 60 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches. Thickness of the mollic epipedon ranges from 8 to 16 inches.

The A horizon has hue of 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is sandy loam, fine sandy loam, or loam. Reaction is slightly acid or neutral. The B horizon has hue of 10YR or 7.5YR, value or 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4. It is sandy loam, fine sandy loam, or loam. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 3 to 6. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand. Reaction ranges from slightly acid to moderately alkaline.

Clime series

The Clime series consists of moderately deep soils that are moderately well drained and have moderately slow permeability. These soils are on uplands. They formed in material weathered from calcareous, clayey shales. Slope ranges from 2 to 25 percent.

Clime soils are similar to Rosehill soils and are commonly adjacent to Labette, Martin, and Sogn soils on the landscape. Rosehill soils do not have free carbonates in the solum. Labette soils have an argillic horizon. Martin soils have an argillic horizon and do not have a paralithic contact within depths of 40 inches. Sogn soils are less clayey and have lithic contact within 20 inches.

Typical pedon of Clime silty clay in an area of Clime-Sogn complex, 2 to 15 percent slopes, 600 feet west and 450 feet north of the southeast corner of sec. 36, T. 31 S., R. 7 E.

A1—0 to 8 inches; dark gray (10YR 4/1) silty clay, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, firm; many fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

B2—8 to 20 inches; grayish brown (10YR 5/2) silty clay; very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; very hard, very firm; many fine roots; horizon contains few shale fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—20 to 36 inches; light gray (5Y 7/2) silty clay, light olive gray (5Y 6/2) moist; massive; very hard, very firm; few fine roots; few shale fragments; strong effervescence; moderately alkaline; diffuse smooth boundary.

Cr—36 inches; olive gray (5Y 5/2) and light olive brown (2.5Y 5/6) calcareous clay shales.

The thickness of the solum ranges from 12 to 30 inches. Depth to calcareous shale ranges from 20 to 40 inches.

The A1 horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is silty clay or heavy silty clay loam. Reaction is mildly alkaline to moderately alkaline. The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5 when dry and 3 when moist, and chroma of 1 to 3. The C horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 to 7 when dry and 4 to 6 when moist; and chroma of 2 to 4. This horizon typically has fragments of calcareous shale but is less than 35 percent, by volume, of coarse fragments.

Dale series

The Dale series consist of deep soils that are well drained and moderately permeable. These soils are on terraces and flood plains. They formed in loamy alluvium. Slope ranges from 0 to 1 percent.

Dale soils are similar to Ivan and Verdigris soils and are commonly adjacent to Canadian and Lesho soils on the landscape. Ivan soils contain free carbonates throughout. Verdigris soils do not have free carbonates within depths of 50 inches. Canadian soils have a coarse-loamy control section. Lesho soils have a fine-loamy control section which is over sandy layers.

Typical pedon of Dale silt loam, 600 feet north and 100 feet east of the southwest corner of sec. 8, T. 32 S., R. 3 E.

Ap—0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; few fine roots; slightly acid, clear smooth boundary.

A12—9 to 28 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist;

moderate medium granular structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

B2—28 to 42 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; hard, friable; weak fine subangular blocky structure; few fine roots; few films and spots of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

C—42 to 60 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; massive; hard, friable; few fine roots; slight effervescence; moderately alkaline.

The thickness of the solum ranges from about 25 to 50 inches. Depth to free carbonates ranges from 20 to 60 inches.

The A horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It commonly is silt loam, but it is also loam. Reaction is slightly acid to neutral. The B2 horizon has hue of 7.5YR or 10YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 3 or 4. Texture of the B2 horizon is similar to the A horizon. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 4 or 5 when moist, and chroma of 3 to 6. The C horizon is commonly loam but it is also silt loam. In some pedons the C horizon has strata of fine sandy loam or silty clay loam below depths of 50 inches. Reaction is mildly or moderately alkaline.

Dwight series

The Dwight series consists of deep soils that are moderately well drained and have very slow permeability. These soils are on uplands. They formed in clayey pedisediments derived largely from clay shales and from some loess or old alluvium. Slope ranges from 0 to 2 percent.

Dwight soils are similar to Irwin and Tabler soils and are commonly adjacent to Irwin, Labette, and Sogn soils on the landscape. Irwin, Labette, Tabler, and Sogn soils do not have a natric horizon. In addition, Labette soils are 20 to 40 inches deep to hard limestone. Sogn soils are less than 20 inches deep to hard limestone.

Typical pedon of Dwight silt loam, 1,200 feet east and 400 feet north of the southwest corner of sec. 18, T. 30 S., R. 5 E.

A1—0 to 5 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine roots, slightly acid; abrupt smooth boundary.

B21t—5 to 15 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong medium columnar structure parting to moderate medium blocky; extremely hard, extremely firm; few fine roots; thick continuous clay films on faces of peds; slightly acid; clear smooth boundary.

B22t—15 to 28 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate medium and coarse blocky structure; extremely hard, extremely firm; few fine roots; thick continuous clay films on faces of peds; few small lime concretions; neutral; gradual smooth boundary.

B3—28 to 44 inches; brown (7.5YR 5/4) silty clay, brown (7.5YR 4/4) moist; common medium distinct strong brown (7.5YR 5/8) and light gray (10YR 7/2) mottles; weak coarse blocky structure; extremely hard, extremely firm; thin patchy clay films on faces of peds; few fine soft lime accumulations; mildly alkaline; gradual wavy boundary.

C—44 to 54 inches; mixed pale brown (10YR 6/3), brownish yellow (10YR 6/6), olive yellow (2.5YR 6/6), and olive (5Y 5/3) silty clay; brown (10YR 4/3), yellowish brown (10YR 5/6), olive brown (2.5YR 4/4) and olive (5Y 4/3) moist; massive, extremely hard, extremely firm, few fragments of shale and limestone; mildly alkaline; clear wavy boundary.

R—54 inches; hard limestone bedrock.

The thickness of the solum ranges from 30 to 55 inches. Depth to hard limestone ranges from 40 to 60 inches. The mollic epipedon ranges from 15 to 30 inches in thickness.

The A horizon has hue of 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is dominantly silt loam, but the texture ranges to silty clay loam. Reaction ranges from medium acid to neutral. The B2t horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5 when dry and 2 to 4 when moist; and chroma of 1 to 3. It is clay or silty clay. Clay content averages between 45 to 60 percent. Reaction ranges from slightly acid to moderately alkaline. The B2t horizon has 10 to 15 percent exchangeable sodium. The B3 and C horizons have hue of 10YR, 7.5YR, or 5YR; value of 4 to 6 when dry and 3 to 5 when moist; and chroma of 3 or 4. They are silty clay, clay, or silty clay loam that is commonly mottled with high and low chroma. Reaction ranges from neutral to moderately alkaline. The B3 horizon has 15 to 20 percent exchangeable sodium.

Florence series

The Florence series consists of deep soils that are well drained and have moderately slow permeability. These soils are on uplands. They formed in residuum that is dominantly weathered from cherty limestone but in places is partly weathered from chert-free limestone or shale. Slope ranges from 5 to 15 percent.

Florence soils are similar to Olpe soils and are commonly adjacent to Dwight, Labette, Martin, and Smolan soils on the landscape. Olpe soils are formed in old gravelly alluvium, and they have a thicker solum than the

Florence soils. Dwight soils have a thin A horizon, and a Bt horizon that is high in sodium salt, Labette, Martin, and Smolan soils do not have chert fragments in the solum.

Typical pedon of Florence cherty silty loam, 5 to 15 percent slopes, (fig. 15) 1,320 feet south and 1,320 feet west of the northeast corner of sec. 9, T. 31 S., R. 6 E.

A1—0 to 14 inches; very dark grayish brown (10YR 3/2) cherty silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; 20 percent by volume of angular chert fragments less than 1 inch in diameter; slightly acid; clear smooth boundary.

B1—14 to 17 inches; dark reddish gray (5YR 4/2) cherty silty clay loam, dark reddish brown (5YR 3/2) moist; moderate medium subangular blocky structure; extremely hard, firm; many fine roots; 80 percent by volume of angular chert fragments 1/2 inch to 3 inches in diameter; slightly acid; clear wavy boundary.

B2t—17 to 30 inches; reddish brown (2.5YR 4/4) coarse cherty clay, dark reddish brown (2.5YR 3/4) moist; moderate fine blocky structure; extremely hard, extremely firm; few fine roots; 50 percent by volume of coarse angular chert fragments; slightly acid; gradual wavy boundary.

B22t—30 to 45 inches; reddish brown (2.5YR 5/4) coarse cherty clay, dark reddish brown (2.5YR 3/4) moist; moderate medium and fine blocky structure; extremely hard, extremely firm; few fine roots; 80 percent by volume of coarse angular chert fragments; mildly alkaline; clear wavy boundary.

R—45 inches; cherty limestone.

The thickness of the solum ranges from 40 to 60 inches and commonly is the same depth to cherty limestone, limestone, or cherty shale. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 1 or 2. It commonly is cherty silt loam or cherty silty clay loam containing up to 50 percent chert fragments, but in some pedons it is chert free. Reaction is slightly acid or neutral. The B2t horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 3 to 5 dry or moist; and chroma of 3 to 6. In some pedons this horizon contains common, distinct mottles that have a hue of 5YR to 2.5YR. Reaction is slightly acid to mildly alkaline. Clay content of the B2t horizon averages between 50 and 80 percent.

Irwin series

The Irwin series consists of deep soils that are well drained and have very slow permeability. These soils are on uplands. They formed in clayey sediments, which are either old alluvium or pedisediments derived largely from clayey shales. Slope ranges from 1 to 3 percent.

Irwin soils are similar to Dwight, Smolan, and Tabler soils and are commonly adjacent to Dwight, Labette, and Rosehill soils on the landscape. Dwight soils have a natric horizon. Smolan soils have montmorillontic mineralogy. Tabler soils are moderately well drained. Labette and Rosehill soils are less than 40 inches deep to bedrock. Rosehill soils do not have an argillic horizon.

Typical pedon of Irwin silty clay loam, 1 to 3 percent slopes, 820 feet south and 150 feet east of the northwest corner of sec. 21, T. 30 S., R. 3 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, firm; few fine roots; slightly acid; abrupt smooth boundary.

A12—7 to 13 inches; dark brown grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine blocky structure; few fine roots; very hard, firm; slightly acid; clear smooth boundary.

B21t—13 to 24 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; extremely hard, very firm; few fine roots; thick continuous clay films on faces of peds; neutral; gradual smooth boundary.

B22t—24 to 40 inches; brown (10YR 5/3) silty clay, dark brown (10YR 3/3) moist; moderate coarse blocky structure; extremely hard, extremely firm; few fine roots; thin continuous clay films on faces of peds; few small clacium carbonate concretions; neutral; clear smooth boundary.

C—40 to 60 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; common distinct dark brown (7.5YR 4/2) and strong brown (7.5YR 5/6) mottles; massive; very hard, very firm; few small calcium carbonate concretions; neutral.

The thickness of the solum ranges from 30 to 60 inches. Depth to limestone or shale is more than 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 1 to 3. It is commonly silty clay loam but ranges to silt loam. Reaction ranges from medium acid to neutral. The B21t horizon has hue of 10YR to 7.5YR, value of 4 or 5 when dry and 3 when moist, and chroma of 2 or 3. It is clay or silty clay, and ranges from medium acid to neutral. The B22t horizon has hue of 10YR to 7.5YR, value of 4 to 6 when dry and 3 to 4 when moist, and chroma of 2 or 3. It is silty clay or clay. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, 7.5YR or 5YR; value of 4 to 6 when dry and 3 or 4 when moist; and chroma of 2 or 3. It is commonly mottled with high and low chroma. It is clay or silty clay. Reaction ranges from neutral to moderately alkaline.

Ivan series

The Ivan series consists of deep soils that are well drained and have moderate permeability. These soils are on flood plains. They formed in recent, calcareous silty alluvium. Slopes range from 0 to 2 percent. Ivan soils in Cowley County are taxadjunct to the Ivan series because they are in a drier climate, but this difference does not alter their usefulness or management.

Ivan soils are similar to Verdigris soils and are commonly adjacent to Martin and Reading soils on the landscape. Verdigris soils have a noncalcareous control section. Martin and Reading soils have an argillic horizon.

Typical pedon of Ivan silt loam, 250 feet west and 50 feet south of the northeast corner of sec. 19, T. 32 S., R. 7 E.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; few fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

Al2—8 to 28 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium and coarse granular structure; soft, friable; few fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C—28 to 60 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; hard, friable; few fine roots; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 50 inches. The depth to free carbonates ranges from 0 to 8 inches. Reaction ranges from slightly mildly alkaline to moderately alkaline in the upper 8 inches, and all horizons are moderately alkaline below 8 inches.

The A horizon has hue of 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. Texture of these horizons ranges from silt loam to light silty clay loam. Clay content averages between 18 to 35 percent clay. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 2 or 3. It is loam, silt loam, or silty clay loam, but strata containing more clay or sand occurs in some pedons.

Labette series

The Labette series consists of moderately deep soils that are well drained and slowly permeable. These soils are on uplands. They formed in residuum weathered from limestone that contains thin beds of clayey shales. Slope ranges from 1 to 8 percent.

Labette soils are similar to Irwin and Smolan soils and are commonly adjacent to Dwight, Florence, Irwin, Smolan, and Sogn soils on the landscape. Dwight soils have a thinner A horizon and contain sodium salt. Florence soils have more than 35 percent, by volume, of chert fragments below a depth of 10 inches. Irwin and Smolan soils lack a lithic contact within depths of 40 inches. In Sogn soils bedrock is at a depth of less than 20 inches.

Typical pedon of Labette silty clay loam, 1 to 3 percent slopes, (fig. 16) 1,000 feet south and 100 feet west of the northeast corner of sec. 30, T. 31 S., R. 5 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

B1—7 to 15 inches, dark brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

B21t—15 to 23 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—23 to 33 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; moderate medium and coarse blocky structure; very hard, very firm; thick continuous clay films on faces of peds; few small fragments of limestone; neutral gradual wavy boundary.

C—33 to 36 inches; reddish brown (2.5YR 5/4) silty clay, dark reddish brown (2.5YR 4/4) moist; weak coarse blocky structure; very hard, very firm; common soft fragments of calcareous shale; neutral; clear wavy boundary.

R—36 inches; hard jointed limestone.

The thickness of the solum and depth to bedrock range from 20 to 40 inches. The solum is medium acid or slightly acid in the upper part and slightly acid to mildly alkaline in the lower part.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. The B1 horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 2 or 3. The B2t horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 4 to 6 when dry and 3 to 5 when moist; and chroma of 2 to 6. It is heavy silty clay loam or silty clay. Clay content averages between 35 to 50 percent. The C horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 4 to 6 when dry or moist; and chroma of 4 to 8 when dry or moist. Reaction ranges from neutral to moderately alkaline.

Lesho series

The Lesho series consists of deep soils that are somewhat poorly drained and have moderately slow permeability. These soils are on low terraces and flood plains. They formed in loamy and sandy, calcareous alluvium. Slope ranges from 0 to 1 percent.

Lesho soils are commonly adjacent to Canadian and Lincoln soils on the landscape. Canadian soils have a coarse-loamy control section and do not have the contrasting sandy lower horizons that Lesho soils have. Lincoln soils lack a mollic epipedon and have a sandy control section.

Typical pedon of Lesho clay loam, 1,700 feet south and 150 feet west of the northeast corner of sec. 30, T. 32 S., R. 3 E.

A11—0 to 10 inches; dark brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate medium and fine granular structure; hard, friable; few fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

A12—10 to 17 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C—17 to 24 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish red (5YR 4/6) mottles; weak fine granular structure; hard, friable; few fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC—24 to 60 inches; very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; single grained; loose; mildly alkaline.

The thickness of the solum and mollic epipedon ranges from 10 to 20 inches. Depth to the IIC horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value or 3 to 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It commonly is clay loam but ranges to loam. Reaction is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 6. Reaction is mildly alkaline or moderately alkaline. The IIC horizon has hue of 7.5YR, 10YR, or 2.5YR; value of 5 to 7; and chroma of 3 to 6. It is loamy fine sand or sand. Reaction is mildly alkaline or moderately alkaline.

Lincoln series

The Lincoln series consists of deep soils that are somewhat excessively drained and have rapid permeability. These soils are on flood plains. They formed in sandy alluvial sediment. Slopes range from 0 to 2 percent.

Lincoln soils are similar to Tivoli soils and are commonly adjacent to Canadian, Dale, and Lesho soils on the landscape. Tivoli soils do not have strata that are finer than fine sand. Dale soils have a fine-silty control section. Lesho soils have a fine-loamy control section over contrasting sandy layers.

Typical pedon of Lincoln fine sandy loam, from an area of Lincoln-Tivoli complex, 0 to 10 percent slopes, 2,500 feet west and 800 feet north of the southeast corner of sec. 21, T. 33 S., R. 3 E.

A1—0 to 9 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, friable; few fine roots, mildly alkaline; gradual smooth boundary.

C1—9 to 42 inches; pink (7.5YR 7/4) loamy fine sand, light brown (7.5YR 6/4) moist; single grained; soft, very friable; few fine roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—42 to 60 inches; reddish yellow (7.5YR 7/6) loamy fine sand, reddish yellow (7.5YR 6/6) moist; single grained; loose; slight effervescent; moderately alkaline.

The thickness of the solum ranges from 6 to 15 inches. The depth to free carbonates is commonly more than 10 inches. Reaction is mildly alkaline or moderately alkaline in the upper 9 inches and moderately alkaline below 9 inches.

The A1 horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 5. It is commonly fine sandy loam but ranges from loam to loamy fine sand. The C horizon has hue of 5YR or 7.5YR, value of 6 to 8, and chroma of 4 to 6. Thin strata of coarse materials occur throughout most pedons.

Martin series

The Martin series consists of deep soils that are commonly well drained and slowly permeable. These soils are on uplands. They formed in colluvial material that is residuum of interbedded silty and clayey shales and clay beds. Slope ranges from 1 to 11 percent. The Martin soils in Cowley County are taxajunct to the Martin series because they are in a drier climate and have distinct mottles in the lower part of the mollic epipedon. The difference does not alter their usefulness of management.

Martin soils are commonly adjacent to Florence, Labette, Reading, and Sogn soils on the landscape. Florence soils contain more than 35 percent, by volume, of chert fragments below a depth of 10 inches. Labette soils have lithic contact at depths of 20 to 40 inches. Reading soils have a fine-silty control section. Sogn soils have lithic contact at depths less than 20 inches.

Typical pedon of Martin silty clay loam, 3 to 7 percent slopes, (fig. 17) 2,200 feet south and 100 feet west of the northeast corner of sec. 26, T. 31 S., R. 7 E.

A1—0 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark brown (10YR 2/2) moist; strong medium and coarse granular structure; hard, friable; many fine roots; slightly acid; clear smooth boundary.

B1—9 to 15 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) moist; strong fine subangular blocky structure; very hard, firm; many fine roots; thin patchy clay films on faces of peds; slightly acid; clear smooth boundary.

B21t—15 to 30 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; few fine distinct brown (7.5YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; common fine black concretions; slightly acid; gradual smooth boundary.

B22t—30 to 42 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/8) mottles; strong medium blocky structure; extremely hard, very firm; few fine roots; thick continuous clay films on faces of peds; many fine black concretions; few fine shale fragments; neutral; gradual wavy boundary.

B3—42 to 60 inches; yellowish brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) moist; common distinct reddish yellow (7.5YR 6/8) and strong brown (7.5YR 5/8) mottles; weak medium blocky structure; very hard, very firm; few fine roots; many fine black concretions; few fine shale fragments; neutral.

The thickness of the solum ranges from 40 to 60 inches, and depth to shale or clay beds is more than 40 inches. The mollic epipedon is more than 20 inches thick and extends into the upper part of the argillic horizon.

The A horizon has 10YR hue, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 1 or 2. Reaction is medium acid or slightly acid. The B1 horizon has colors and reaction similar to those of the A horizon. The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 when dry and 2 to 4 when moist, and chroma of 1 or 2 in the upper part and 1 to 4 in the lower part. It is clay or silty clay. Clay content averages between 40 to 55 percent clay. Reaction is slightly acid or neutral. Mottles are few and distinct in the upper part of the B2t horizon and are common and distinct in the lower part of the B2t horizon and in the B3 horizon. The B3 and C horizons are mottled clay or silty clay. Their reaction is neutral or mildly alkaline. Black concretions are in the B2t or B3 horizons.

Milan series

The Milan series consists of deep soils that are well drained and have moderately slow permeability. These soils are on uplands. They formed in loamy, old alluvium. Slope ranges from 1 to 5 percent.

Milan soils are similar to Norge soils and are commonly adjacent to Attica and Vanoss soils on the landscape. Norge soils have a fine-silty control section. Attica soils have a coarse-loamy control section and do not have a mollic epipedon. Vanoss soils have a fine-silty control section.

Typical pedon of Milan fine sandy loam, 1 to 5 percent slopes, 2,000 feet north and 1,340 feet west of the southeast corner of sec. 21, T. 34 S., R 4 E.

Ap—0 to 9 inches; brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, friable; few fine foots; medium acid; clear smooth boundary.

B21t—9 to 13 inches; reddish brown (5YR 4/3) sandy clay loam; dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, firm; few fine roots; medium acid; gradual smooth boundary.

B22t—13 to 30 inches; reddish brown (2.5YR 4/4) sandy clay loam; dark reddish brown (2.5YR 3/4) moist; strong medium subangular blocky structure; hard, firm; few fine roots; neutral; gradual smooth boundary.

B3—30 to 40 inches; red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) moist; weak medium subangular blocky structure; hard, firm; few fine roots; neutral; gradual smooth boundary.

C—40 to 60 inches; red (2.5YR 5/6) sandy loam, red (2.5YR 4/6) moist; massive; hard, friable; neutral.

The thickness of the solum ranges from 35 to 50 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is commonly fine sandy loam but includes loam. Reaction is medium acid or slightly acid. The B2t horizon has hue of 2.5YR or 5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 3 to 7. It is sandy clay loam or clay loam. Clay content averages between 28 and 35 percent. Reaction ranges from medium acid to neutral. The B3 horizon and C horizon have colors and reaction similar to those in the B2t horizon. The C horizon typically is less clayey than the B2t or B3 horizons, but some pedons have thin strata of mottled clay or sandy clay.

Minco series

The Minco series consists of deep soils that are well drained and are moderately permeable. These soils are on uplands. They formed in eolian sediments. Slope ranges from 3 to 25 percent.

Minco soils are similar to Canadian and Vanoss soils and are commonly adjacent to Canadian, Vanoss, and Milan soils on the landscape. Vanoss soils have an argillic horizon and a fine-silty control section. Canadian soils have a coarse-loamy control section. Milan soils have an argillic horizon and fine-loamy control section.

Typical pedon of Minco silt loam, 3 to 7 percent slopes, 450 feet south and 25 feet east of the northwest corner of sec. 1, T. 35 S., R. 3 E.

Ap—0 to 7 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine and medium granular structure; soft, very friable; few fine roots; medium acid; clear smooth boundary.

A12—7 to 15 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; strong fine and medium granular structure; soft, friable, few fine roots; slightly acid; gradual smooth boundary.

B21—15 to 30 inches; brown (7.5YR 5/4) silt loam, brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

B22—30 to 42 inches; brown (7.5YR 5/4) silt loam, brown (7.5YR 4/4) moist; moderate medium prismatic structure; slightly hard, friable; few fine roots; few fine sand grains on faces of peds; neutral; gradual smooth boundary.

C—42 to 60 inches; yellowish red (5YR 5/6) silt loam, reddish brown (5YR 4/4) moist; massive; porous; hard, friable; mildly alkaline.

The thickness of the solum ranges from 25 to 60 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 or 3. It is commonly silt loam but includes very fine sandy loam. Reaction ranges from medium acid to neutral. The B horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry and 4 or 5 when moist, and chroma of 4 to 6. Reaction is slightly acid or neutral. The C horizon has hue of 5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 4 to 6. It is silt loam or very fine sandy loam. Reaction is slightly acid to mildly alkaline. Some pedons are fine sandy loam below a depth of 40 inches.

Norge series

The Norge series consists of deep soils that are well drained and have moderately slow permeability. These soils are on uplands. They formed in loamy sediments which are a mixture of loess and alluvium. Slope ranges from 1 to 7 percent.

Norge soils are similar to Vanoss soils and are commonly adjacent to Bethany, Minco, and Vanoss soils on the landscape. Vanoss soils decrease in clay content by more than 20 percent within 60 inches of the surface. Their B2t and B3 horizons have a browner hue than 5YR. Bethany soils have a mollic epipedon more than 20 inches thick. Minco soils have a coarse-silty control section.

Typical pedon of Norge silt loam, 1 to 3 percent slopes, (fig. 18) 1,100 feet west and 150 feet south of the northeast corner of sec. 22, T. 33 S., R. 4 E.

Ap—0 to 8 inches; dark brown (7.5YR 5/3) silt loam, dark brown (7.5YR 3/3) moist; weak fine granular structure; soft, very friable; few fine roots; slightly acid; clear smooth boundary.

B1—8 to 18 inches; reddish brown (5YR 5/3) silty clay loam, dark reddish brown (5YR 3/3) moist; weak fine subangular blocky structure; hard, friable; few fine roots; neutral; clear smooth boundary.

B21t—18 to 28 inches; reddish brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm; few fine roots; thick patchy clay films on faces of peds; neutral; gradual smooth boundary.

B22t—28 to 39 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; strong medium blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; few fine black concretions; neutral; gradual smooth boundary.

B3—39 to 60 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; weak coarse subangular blocky structure; very hard, firm; thin patchy clay films on faces of peds; few fine sand grains on faces of peds; few fine black concretions; neutral.

The thickness of the solum is more than 60 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 moist, and chroma of 2 or 3. It is dominantly silt loam, but the range includes loam and silty clay loam. Reaction is medium acid or slightly acid. The B1 horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. Reaction is slightly acid or neutral. The B2t horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry or moist, and chroma of 4 to 6. It is silty clay loam. Reaction is slightly acid or neutral. The B3 horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry or moist, and chroma of 4 to 8. It is silty clay loam or clay loam. Reaction ranges from slightly acid to mildly alkaline. Some pedons have mottles in shades of brown or red.

Olpe series

The Olpe series consists of deep soils that are well drained and have slow permeability. These soils are on

uplands. They formed in old gravelly sediments believed to be ancient alluvium and some admixture of loess. Slope ranges from 2 to 12 percent. Olpe soils in Cowley County are taxajunct to the Olpe series because they are in a drier climate. This difference does not alter their usefulness or management.

Olpe soils are similar to Florence soils and are commonly adjacent to Labette, Martin, and Smolan soils on the landscape. Florence soils formed in residuum weathered from cherty limestone. Labette soils have lithic contact within depths of 20 to 40 inches. Martin and Smolan soils do not have many chert fragments in the solum that the Olpe soils have.

Typical pedon of Olpe gravelly silt loam, 2 to 12 percent slopes, (fig. 19) 2,340 feet north and 1,320 feet east of the southwest corner of sec. 21, T. 34 S., R. 5 E.

A11—0 to 10 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; 15 percent by volume of rounded chert gravels; slightly acid; gradual wavy boundary.

A12—10 to 16 inches; brown (7.5YR 4/3) gravelly silty clay loam, dark brown (7.5YR 3/3) moist; moderate medium granular structure; hard, friable; many fine roots; about 30 percent by volume of rounded chert pebbles; medium acid; gradual wavy boundary.

B1—16 to 22 inches; reddish brown (5YR 4/4) gravelly silty clay loam, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm; many fine roots; about 80 percent by volume of rounded chert pebbles; medium acid; gradual wavy boundary.

B21t—22 to 36 inches; reddish brown (5YR 5/4) gravelly silty clay, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; very hard, very firm; thin continuous clay films on faces of peds; about 85 percent by volume of rounded chert pebbles; medium acid; gradual wavy boundary.

B22t—36 to 48 inches; yellowish red (5YR 5/6) gravelly silty clay, yellowish red (5YR 4/6) moist; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; continuous clay films on faces of peds; 80 percent by volume of rounded chert pebbles; medium acid; gradual wavy boundary.

B3—48 to 60 inches; coarsely mottled yellowish red (5YR 5/6) and light yellowish gray (2.5YR 6/3) moist or dry, gravelly silty clay; weak coarse angular blocky structure; extremely hard, very firm; thick patchy clay films on faces of peds; about 50 percent by volume of rounded chert pebbles; medium acid.

The thickness of the solum is more than 60 inches, and the thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 2 or 3. It is typically gravelly silt loam but includes gravelly silty clay loam. Reaction is medium acid or slightly acid. The B1 horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 3 or 4. It is gravelly silty clay loam or gravelly silty clay. Reaction is medium acid or slightly acid. The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 4 to 6. Reaction ranges from medium acid to neutral. The B3 horizon has hue of 2.5YR or 5YR, value of 4 to 6 when dry and 4 or 5 when moist, and chroma of 3 to 6. It is mottled with colors that are redder in hue and higher in chroma. Reaction is medium acid to mildly alkaline.

Osage series

The Osage series consists of deep soils that are poorly drained and have very slow permeability. These soils are on nearly level flood plains. They formed in thick clayey alluvium. Slope ranges from 0 to 1 percent.

Osage soils are commonly adjacent to Brewer and Verdigris soils on the landscape. Brewer soils have an argillic horizon. Verdigris soils have a fine-silty control section.

Typical pedon of Osage silty clay, 1,120 feet east and 18 feet north of the southwest corner of sec. 30, T. 30 S., R. 4 E.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak fine granular structure; extremely hard, firm; few fine roots; slightly acid; clear smooth boundary.

A12—7 to 12 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate fine blocky structure; extremely hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

A13—12 to 18 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; few fine faint very dark gray (N 3/0) mottles; moderate fine blocky structure; extremely hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

B21g—18 to 28 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine and medium blocky structure; extremely hard, extremely firm; few fine roots; few slickensides; neutral; gradual smooth boundary.

B22g—28 to 37 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; few fine faint dark brown (10YR 4/3) mottles; weak medium blocky structure; extremely hard, extremely firm; few fine roots; few slickensides; neutral; gradual smooth boundary.

B3g—37 to 60 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; few medium distinct

olive brown (2.5Y 4/4) mottles; massive; extremely hard, extremely firm; few slickensides; neutral.

The thickness of the solum ranges from 40 to 60 inches or more.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 1 or 2. The A horizon is silty clay or heavy silty clay loam. Reaction is medium acid to neutral. Typically the 10 to 40 inch control section has an average clay content of 46 to 60 percent. The Bg horizon has hue of 10YR or 2.5Y, value of 3 to 5 when dry or moist, and chroma of 1 or less. Its mottles are of a higher chroma. Reaction of the Bg horizon ranges from medium acid to mildly alkaline. In some pedons the lower part of the B horizon has gypsum crystals.

Reading series

The Reading series consists of deep soils that are well drained and have moderately slow permeability. These soils are on stream terraces. They formed in thick silty alluvium. Slope ranges from 0 to 2 percent. Reading soils in Cowley County are taxajunct to the Reading series because they are in a drier climate. This difference does not alter their usefulness or management.

Reading soils are similar to Vanoss and Martin soils and are commonly adjacent to Ivan and Martin soils on the landscape. Vanoss soils have a mollic epipedon less than 20 inches thick. Ivan soils do not have an argillic horizon and are calcareous throughout. Martin soils have a fine control section.

Typical pedon of Reading silt loam, 1,320 feet south and 1,600 feet east of the northwest corner of sec. 31, T. 32 S., R. 7 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine granular structure; soft, friable; many fine roots; slightly acid; gradual smooth boundary.

A12—7 to 14 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong medium and coarse granular structure; soft, very friable; many fine roots; slightly acid; clear smooth boundary.

B21t—14 to 22 inches; dark brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; strong fine subangular blocky structure; hard, friable; few fine roots; thin patchy films on faces of peds; slightly acid; gradual smooth boundary.

B22t—22 to 43 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; very hard, firm; thick patchy clay films on faces of peds; few fine roots; slightly acid; gradual smooth boundary.

B3—43 to 50 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm; few fine roots; slightly acid; diffuse boundary.

C—50 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, dark brown (10YR 4/3) moist; massive; hard, firm; neutral.

The thickness of the solum ranges from 40 inches to more than 60 inches. The mollic epipedon is more than 24 inches thick. Reaction is slightly acid or medium acid in the A and B horizons, and ranges from neutral to mildly alkaline in the C horizon. The A horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 to 3. The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 when dry and 2 to 4 when moist, and chroma of 2 to 4. Clay content averages between 27 and 35 percent. The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4.

Rosehill series

The Rosehill series consists of moderately deep soils that are well drained and have very slow permeability. These soils are on uplands. They formed in material weathered from clayey shales. Slope ranges from 1 to 6 percent.

Rosehill soils are similar to Clime soils and are commonly adjacent to Irwin and Tabler soils on the landscape. Clime soils have free carbonates within depths of 10 inches. Irwin and Tabler soils lack shale within a depth of 40 inches, and have an argillic horizon.

Typical pedon of Rosehill silty clay, 1 to 3 percent slopes, 1,830 feet west and 450 feet north of the southeast corner of sec. 19, T. 30 S., R. 3 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, firm; few fine roots; neutral; clear smooth boundary.

B1—8 to 15 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak fine blocky structure; very hard, firm; few fine roots; neutral; clear wavy boundary.

B2—15 to 20 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; many streaks of very dark grayish brown (10YR 3/2); weak coarse blocky structure; extremely hard, extremely firm; neutral; clear wavy boundary.

C1—20 to 37 inches; mixed yellow (10YR 7/8), light brownish gray (2.5Y 6/2), and reddish brown (5YR 5/4) clay, yellowish brown (10YR 5/8), dark grayish brown (2.5Y 4/2), and reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm; few fragments of soft shale; slight effervescence; mildly alkaline; gradual wavy boundary.

Cr—37 to 46 inches; pale olive (5Y 6/3) and light gray (5Y 7/2) clayey shales with thin seams of soft calcium carbonate.

The thickness of the solum ranges from 20 to 40 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches. Depth to clayey shales ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 1 or 2. It is silty clay or heavy silty clay loam. Reaction is slightly acid or neutral. The B horizon has hue of 10YR, 2.5Y or 5Y; value of 5 to 7 when dry and 3 to 5 when moist; and chroma of 2 to 4. It is clay or silty clay. Reaction ranges from neutral to moderate alkaline. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 2 to 4. It is clay or silty clay. Reaction is mildly alkaline or moderate alkaline.

Smolan series

The Smolan series consists of deep soils that are well drained and slowly permeable. These soils are on uplands. They formed in old silty sediments. Slope ranges from 1 to 7 percent.

Smolan soils are similar to Irwin and Labette soils and are commonly adjacent to Dwight, Irwin, and Labette soils on the landscape. Irwin soils have mixed mineralogy. Dwight soils have a thinner A horizon and have a natric horizon. Labette soils have a lithic contact within depths of 20 to 40 inches.

Typical pedon of Smolan silty clay loam, 1 to 3 percent slopes, 250 feet west and 600 feet south of the northeast corner of sec. 6, T. 32 S., R. 4 E.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine granular structure; hard, friable; many fine roots; medium acid; clear smooth boundary.

B1—8 to 15 inches; dark brown (7.5YR 4/2) silty clay loam; dark brown (7.5YR 3/2) moist; strong fine subangular blocky structure; hard, firm; many fine roots; slightly acid; clear smooth boundary.

B21t—15 to 30 inches; brown (7.5YR 5/3) silty clay, dark brown (7.5YR 3/3) moist; moderate medium blocky structure; very hard, very firm; many fine roots; thick continuous clay films on faces of peds; few fine black concretions; neutral; gradual smooth boundary.

B22t—30 to 40 inches; reddish brown (5YR 5/3) silty clay, reddish brown (5YR 4/3) moist; weak coarse blocky structure; extremely hard; extremely firm; few fine roots; thin patchy clay films on faces of peds; few fine black concretions; few small lime concretions; neutral; gradual smooth boundary.

C—40 to 60 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm; few fine black concretions; few small lime concretions; neutral.

The thickness of the solum ranges from 38 to 60 inches. The mollic epipedon is thicker than 20 inches and extends into the argillic horizon.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It ranges from silty clay loam to silt loam. Reaction is medium acid to neutral. The B1 horizon has hue 10YR to 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. Reaction is medium acid to neutral.

The B2t horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 6. Reaction ranges from slightly acid to mildly alkaline. The C horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 4 to 7 when dry and 3 to 6 when moist; and chroma of 4 to 6. Reaction ranges from neutral to mildly alkaline.

Sogn series

The Sogn series consists of shallow soils that are somewhat excessively drained and have moderate permeability. These soils are on uplands. They formed in loamy residuum weathered from the underlying limestone. Slope ranges from 0 to 10 percent.

Sogn soils are commonly adjacent to Clime, Dwight, Florence, Labette, and Martin soils on the landscape. Clime soils have a fine control section and are over shale. Dwight, Florence, Labette, and Martin soils have an argillic horizon, and all are more than 20 inches thick over bedrock.

Typical pedon of Sogn silty clay loam, 0 to 10 percent slopes, (fig. 20) 1,650 feet east and 2,600 feet south of the northwest corner of sec. 8, T. 31 S., R. 5 E.

A1—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium and coarse granular structure; hard, friable; many fine roots; slightly acid; abrupt smooth boundary.

R—10 inches; level-bedded, indurated limestone that has small cracks filled with dark colored soil.

The thickness of the solum and depth to limestone ranges from 4 to 20 inches. Reaction of the solum ranges from slightly acid to moderately alkaline. The A horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 to 3. In many pedons the soil contains free carbonates and fragments of limestone.

Tabler series

The Tabler series consists of deep soils that are moderately well drained and very slowly permeable. These soils are on uplands. They formed in old, calcareous, clayey alluvium. Slope ranges from 0 to 3 percent.

Tabler soils are similar to Bethany, Brewer, and Irwin soils and are commonly adjacent to Bethany, Irwin, and Waurika soils on the landscape. Bethany and Irwin soils are well drained and do not have vertic properties. Brewer soils are on terraces and flood plains and also do not have vertic properties. Waurika soils have an A2 horizon.

Typical pedon of Tabler silty clay loam, 0 to 1 percent slopes, 1,000 feet north and 170 feet west of the southeast corner of sec. 2, T. 33 S., R. 3 E.

Ap—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium and fine granular structure; hard, friable; few fine roots; slightly acid; abrupt smooth boundary.

B21t—8 to 22 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate medium blocky structure; extremely hard, very firm; few fine roots; thick continuous clay films on faces of peds; neutral; gradual smooth boundary.

B22t—22 to 34 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; few fine faint brown (7.5YR 5/4) mottles; weak medium blocky structure; extremely hard, very firm; few fine roots; thick continuous clay films on faces of peds; neutral; clear smooth boundary.

B3t—34 to 48 inches; grayish brown (10YR 5/2) silty clay, dark gray (10YR 4/1) moist; few fine faint brown (7.5YR 5/4) and very dark gray (10YR 3/1) mottles; weak medium blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; slight effervescence; mildly alkaline; gradual wavy boundary.

C—48 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; common coarse distinct strong brown (7.5YR 5/6) mottles; massive; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is more than 20 inches thick and extends into the B horizon.

The A horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is dominantly silty clay loam texture, but ranges to silt loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is clay or silty clay. Reaction ranges from slightly acid to mildly alkaline. The B3t horizon has hue of I0YR or 2.5Y, value of 4 to 7 when dry and 3 or 4 when moist, and chroma of 1 to 3. It is clay, silty clay, or silty clay loam. Reaction ranges from neutral to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 when dry and 3 to 6 when moist, and chroma of 1 to 3. It is clay, silty clay, or silty clay loam, Reaction is mildly alkaline or moderately alkaline. Mottles are shades of gray, brown, or red.

Tivoli series

The Tivoli series consists of deep soils that are excessively drained and have rapid permeability. These soils are on uplands. They formed in sandy eolian deposits. Slope ranges from 5 to 15 percent.

Tivoli soils are similar to Lincoln soils and are commonly adjacent to Attica and Lincoln soils on the landscape. Lincoln soils formed in sandy alluvium on flood plains. Attica soils have an argillic horizon. In Cowley County, Tivoli soils are mapped only in complexes with Attica and Lincoln soils.

Typical pedon of Tivoli loamy fine sand, from an area of Attica-Tivoli loamy fine sand, 3 to 15 percent slopes, 1,300 feet north and 1,600 feet west of the southeast corner of sec. 21, T. 33 S., R. 3 E.

A1—0 to 7 inches; brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) moist; single grained; loose, very friable; many fine roots; neutral; gradual smooth boundary.

C—7 to 60 inches; very pale brown (10YR 7/4) fine sand, yellowish brown (10YR 5/4) moist; single grained, loose; roots decrease as depth increases; neutral.

The thickness of the solum ranges from 4 to 10 inches. Reaction ranges from slightly acid to mildly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4. It is dominantly loamy fine sand, but texture ranges to fine sand. The C horizon has hue of 5YR, 7.5YR, or 10YR; value of 5 to 7 when dry and 4 to 6 when moist; and chroma of 3 to 6. It is fine sand or sand.

Vanoss series

The Vanoss series consists of deep soils that are well drained and moderately permeable. These soils are on uplands. They formed in silty eolian and alluvial material. Slope ranges from 0 to 7 percent.

Vanoss soils are similar to Norge and Minco soils and are commonly adjacent to Bethany, Minco, and Norge soils on the landscape. Norge soils have hues that are redder than 7.5YR in the Bt horizon. They do not decrease in clay content within 60 inches of the surface. Minco soils do not have an argillic horizon. Bethany soils have a fine textured control section.

Typical pedon of Vanoss silt loam, 1 to 3 percent slopes, 2,000 feet east and 700 feet south of the northwest corner of sec. 27, T. 34 S., R. 3 E.

Ap—0 to 8 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; strong medium and fine granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

A12—8 to 12 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; strong coarse granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

B21t—12 to 20 inches; brown (7.5YR 5/3) silty clay loam, dark brown (7.5YR 3/3) moist; strong medium subangular blocky structure; hard, friable; few fine roots; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—20 to 38 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; weak medium and coarse subangular blocky structure; very hard, friable; few fine roots; thin patchy clay films on faces of peds; slightly acid; gradual wavy boundary.

B3—38 to 60 inches; brown (7.5YR 5/4) silt loam, dark brown (7.5YR 4/4) moist; common fine distinct yellowish red (5YR 4/6) mottles; weak coarse subangular blocky structure; hard, friable; few fine roots; neutral.

The thickness of the solum ranges from 40 inches to more than 60 inches. Thickness of the mollic epipedon ranges from 10 to 19 inches.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is dominantly silt loam, but texture ranges to loam. Reaction is slightly acid or medium acid. The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 3 or 4. It is clay loam or silty clay loam and averages between 27 and 35 percent clay. Reaction is slightly acid or medium acid. The B3 horizon has hue of 7.5YR or 10YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 3 to 6. It is dominantly loam, but texture ranges to clay loam and silt loam. Reaction is slightly acid or neutral.

Verdigris series

The Verdigris series consists of deep soils that are moderately well drained and have moderate permeability. These soils are on low terraces and flood plains. They formed in silty alluvium. Slope ranges from 0 to 2 percent. Verdigris soils in Cowley County are taxadjunct to the Verdigris series because they are in a drier climate. This difference does not alter their usefulness or management.

Verdigris soils are similar to Ivan soils and are commonly adjacent to Brewer, Martin, and Osage soils on the landscape. Ivan soils have free carbonates throughout the control section. Brewer and Martin soils have an argillic horizon and are fine. Osage soils have a fine textured control section.

Typical pedon of Verdigris silt loam, 1,200 feet south and 150 feet east of the northwest corner of sec. 19, T. 30 S., R. 7 E.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; few fine roots; slightly acid; clear smooth boundary.

A12—8 to 16 inches; dark gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; strong medium granular structure; slightly hard, very friable; few fine roots; slightly acid; gradual smooth boundary.

A13—16 to 29 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, friable; many fine roots; gradual smooth boundary.

AC—29 to 38 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; few fine faint strong brown (7.5YR 5/6) mottles; weak medium and fine granular structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

C—38 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; few fine faint strong brown (7.5YR 5/6) mottles; weak fine blocky structure; very hard, firm; neutral.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon ranges from 24 inches to more than 50 inches in thickness. Reaction, to depths of 50 inches or more, ranges from medium acid to neutral.

The A horizon has hue of 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 to 3. The AC horizon has color similar to that of the A1 horizon. The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 4. It ranges from loam to silty clay loam. In some places it contains faint mottles of higher chroma or lower value or both. In other pedons mottles are not present in the C horizon.

Waurika series

The Waurika series consists of deep soils that are somewhat poorly drained and have very slow permeability. These soils are on uplands. They formed in old alluvium and loess. Slope ranges from 0 to 1 percent.

Waurika soils are similar to Tabler soils and are commonly adjacent to Bethany, Tabler, and Vanoss soils on the landscape. All of these soils do not have an A2 horizon.

Typical pedon of Waurika silt loam, 1,430 feet south and 420 feet east of the northwest corner of sec. 8, T. 35 S., R. 3 E.

Ap—0 to 7 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; massive; slightly hard, friable; few fine roots; medium acid; clear smooth boundary.

A12—7 to 10 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

A2—10 to 12 inches; gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; massive; slightly hard, very friable; few fine roots; neutral; abrupt wavy boundary.

B2t—12 to 37 inches; dark gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine blocky structure; very hard, very firm; few fine roots; few fero-manganese concretions; thick continuous clay films on faces of peds; neutral; gradual smooth boundary.

B3ca—37 to 60 inches; gray (10YR 6/1) silty clay loam, dark gray (10YR 4/1) moist; few fine distinct strong brown (7.5YR 5/6) mottles; very hard, firm; few lime concretions; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 inches to more than 60 inches. The mollic epipedon includes the upper part of the argillic horizon in most pedons.

The A1 horizon has hue of 10YR or 7.5YR, value of 3 to 5 when dry and 2 to 3 when moist, and chroma of 1 or 2. Reaction ranges from medium acid to neutral. The A2 horizon is similar to the A1 horizon, except color values are 5 or 6 when dry and 4 or 5 when moist. The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 when dry and 2 to 4 when moist, and chroma of 1 or 2. It is silty clay or clay. Clay content averages between 40 and 50 percent. Reaction is neutral to moderately alkaline. The B3ca horizon has hue of 10YR or 1.5Y, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 1 or 2. It ranges from silty clay loam to clay. Reaction of the B3ca horizon is mildly alkaline or moderately alkaline.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*7*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning ustic moisture regime, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Argiustolls (*Argi*, meaning argillic horizons, plus *ustoll*, the suborder of Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thick dark surface layer. An example is Pachic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, mixed, mesic, Pachic Argiustolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

This section discusses the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation.

Factors of soil formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated by the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil that is formed and, in extreme cases, determine it almost entirely. Finally, time is needed for changing the parent material into a soil. Usually a long time is required for the development of distinct horizons within the soil.

These factors are so closely interrelated in their effects on soil formation that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated material from which soil is formed. Parent material formed by the weathering of rocks through the processes of freezing and thawing, abrasion, erosion, deposition by wind and water, and by chemical processes.

In Cowley County most of the soils east of the Walnut River formed from parent material weathered from Lower Permian rocks consisting of limestone, cherty limestone, and shales. This entire area is underlain by alternating layers of limestone and shales, which crop out in belts extending across the county in a nearly north-south direction. The hard limestone layers, which are more resistant to weathering, form benches or escarpments; the softer shale layers, weathering more readily, form steep eastward-facing slopes between the limestone ledges.

Clime, Labette, and Sogn soils formed in residuum weathered from limestone and closely associated shales. Martin soils, which are closely associated with these soils, are on foot slopes. They formed in colluvial material that is residuum from silty and clayey shales.

Florence soils formed in residuum weathered from cherty limestone. In many places in the eastern part of the county, Labette and Martin soils contain chert that was apparently transported from the higher lying positions.

Some soils appear to have parent material derived from more than one source. For example, the lower parts of the Irwin, Dwight, and Rosehill soils formed from material weathered from shales, but in many places the upper part appears to have been formed in material blown or washed in.

Most of the soils west of the Walnut River formed from terrace deposits of the Pleistocene age. These deposits consisted of eolian sands and silts, clays, and alluvium. The soils in this area are smooth to gently sloping. Pleistocene terrace deposits, mostly silts and clays, also occur in all stream valleys throughout the central and eastern parts of the county.

Alluvium is the parent material for the soils formed on the flood plains and terraces along all the streams in the county. Alluvial material ranges from coarse and fine sands on first bottoms of the Arkansas River to silts and dense clays on terraces of the Walnut River and other streams. Alluvium also ranges in age from old to recent deposits.

Verdigris, Dale, Reading, and Ivan soils are formed from recently deposited silty alluvium. Canadian soils are formed from recently deposited, moderately sandy alluvium. Lesho soils are formed from recently deposited loamy and clayey alluvium. Bethany, Tabler, Waurika, Brewer, and Osage soils are formed from old, clayey alluvial deposits. Olpe soils are formed from old gravelly alluvium.

Eolian, or wind blown deposits, are the parent material for some soils in the county. Eolian deposits range from sandy to silty textures. Vanoss, Minco, Norge, and Smolan soils are formed from eolian silts. Attica soils formed from moderately sandy eolian deposits, and Tivoli soils formed from sandy eolian deposits.

Climate

Climate affects the development of soils in many ways. Rain, snow, and ice, as well as variations in temperature that cause freezing and thawing, disintegrate the rocks or layers of debris on the surface of the earth. Climate also influences the formation of soils that develop from this disintegrated material. Temperature and moisture affect the kind and amount of vegetation that grows and, therefore, indirectly influence the kind and amount of organic matter in the soil and the rate of decomposition of the organic matter. Temperature also affects the growth of organisms and the speed of chemical reaction in the soil. Wind also influences soil formation by blowing particles of soil from one area to another, thus modifying the texture of the surface layer. Some

soils in the county influenced in this way are the Attica, Canadian, Minco, and Tivoli soils.

The movement of moisture through the soil and variations in temperature affect the kind of soil formed. When moisture penetrates the soil, it leaches out minerals and nutrients and moves the fine particles of soil downward. The percolation of water is a major factor in transforming the parent material into a soil. The amount of water that percolates through the soil depends on the amount, type, and intensity of precipitation; humidity; relief; temperature; and the nature of the soil material.

Soil-forming factors are most active when the soil is warm and moist. Lack of rainfall for periods aids in soil development. Many of the clay soils crack when dry; this increases the movement of water through the soil when it rains. Climate indirectly affects many alluvial soils, because in periods of heavy rainfall the streams flood and deposit silt on some bottom lands. The Ivan and Verdigris soils are such alluvial soils.

The structure of the soil is modified by freezing and thawing. Freezing and thawing of clay soils tend to form the surface layer into aggregates. This is particularly noticeable on Tabler and Osage soils. After tillage and wet periods, much of the aggregation is destroyed. The alternate wetting and drying and freezing and thawing is an important part in the process of soil formation in this county.

Plant and animal life

Plants and animals living on or in the soil are active in the soil-forming processes. Living organisms affect the chemistry of the soil and hasten soil development. The effect of vegetation on soil formation is most easily recognized in Cowley County. Prairie grasses provided the organic matter, which has darkened the uppermost layers of the soils.

The important functions of plant and animal life in the soil-forming processes are furnishing organic matter and bringing up nutrients from the lower layers to the surface layer. The important sources of organic matter are the stems, leaves, trunks, and roots of plants. This organic material modifies the color, structure, and other chemical and physical properties of the soil, thus creating a favorable environment for biological activity. More organic material is added where the water relationship is favorable and grasses grow high. For example, the nearly level areas of Bethany and Tabler soils are commonly darkened to a greater depth than the gently sloping areas. For years the nearly level areas had a more favorable moisture regime, more organic matter was added, and little soil was lost by erosion.

Earthworms and small burrowing animals influence the soil by mixing organic and mineral parts of the soil thus deepening the zone where organic matter accumulates. Earthworm activity is particularly noticeable in soils where the organic-matter content is higher. Tabler, Osage, Verdigris, Ivan, Brewer, and Reading soils all show signs of earthworm activity, an important part of the soil development.

The soils in Cowley County formed under tall grass prairie, which supplies quantities of organic matter. This makes the surface layer dark colored and gives it a strong structure. Some soils, such as those of the Sogn and Dwight series, support mid and short grasses. Soils that formed under the shorter grasses are commonly darkened less deeply, because less organic material is added from grass residue.

Relief

Relief, or lay of the land, modifies the influences of the active factors of soil formation. Relief influences soil formation by controlling drainage, runoff, erosion, and vegetation. The amount of water that moves through the soil depends partly on topography. As a rule, less water enters the soil on steep slopes, and more soil material is removed by erosion, than on gentler slopes. Nearly level soils on uplands generally have a more strongly developed profile than steep soils. This is caused by a slower rate of runoff in the level areas, which allows more water to percolate through the soil and lessens the removal of soil from the surface. On low and flat topography, the soil generally receives extra water in the form of runoff from higher lying soils. This additional water is reflected in gray or mottled colors in the subsoil. Evidence of this shows up in the subsoil of Tabler, Osage, and Waurika series.

Some soils have developed on slopes where the processes of erosion have been active. Soils formed on these kinds of slopes are young in terms of soil formation. In places the Clime soils have slopes of 2 to 25 percent. On these slopes, soft shale is the parent material and the erosion process has been active. As a result of relief and the nature of the parent material, the Clime soils are calcareous in all horizons. In other areas where the parent material is similar shale, and where the relief and slope are gentler, a leached soil, such as a Martin soil, has formed.

Time

The length of time required for a soil to form depends on the combined action of the soil-forming factors. If the factors of soil formation have not operated long enough to allow formation of definite horizons, the soil is considered young, or immature. Mature soils are those that have been in place for a long time and have approached equilibrium with their environment. They have well defined horizons.

The youngest soils in Cowley County have formed in recently deposited alluvium. These include the Lincoln, Canadian, Lesho, Verdigris, and Ivan soils, which show very little profile development. Some of the oldest soils in the county have formed in old alluvium. These include

the Tabler, Bethany, Waurika, and Brewer soils which have well defined horizons. Soils from eolian deposits range from immature to mature. Tivoli soils have little development; Attica and Minco soils have weak development, while Vanoss, Smolan, and Norge soils have well defined horizons. Sogn soils have been developing a long time; but their horizons are not so well expressed because their parent material is resistant to weathering and because geologic erosion has removed soil material almost as fast as it formed.

References

(1) American Association of State Highway (and Transportation) Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 474 pp., illus.

(3) Kansas Water Resources Board. 1960. State water plan studies, part A. Prelim. appraisal Kansas water problems, sec. 5, Walnut-Verdigris unit. 160 pp., illus.

(4) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. (Supplements replacing pp. 173-188 issued May 1962)

(5) Bayne, Charles K. 1962. Geology and ground-water resources of Cowley County, Kansas. Univ. Kans., State Geol. Surv. of Kans. Bull. 158: 219 pp., illus.

(6) United States Department of Agriculture. 1967. Kansas conservation needs inventory. Soil Conserv. Serv., 191 pp., illus.

(7) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Environmental plantings. Plantings made for scenic purposes, to enhance the environment.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fast intake. The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and

steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Piping. Moving water of subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there

is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal

forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decompositon of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

ILLUSTRATIONS

Figure 1.—Typical landscape in Dale-Canadian-Lincoln map unit. Trees are on Lincoln soils, and the adjacent terrace is Dale and Canadian soils.

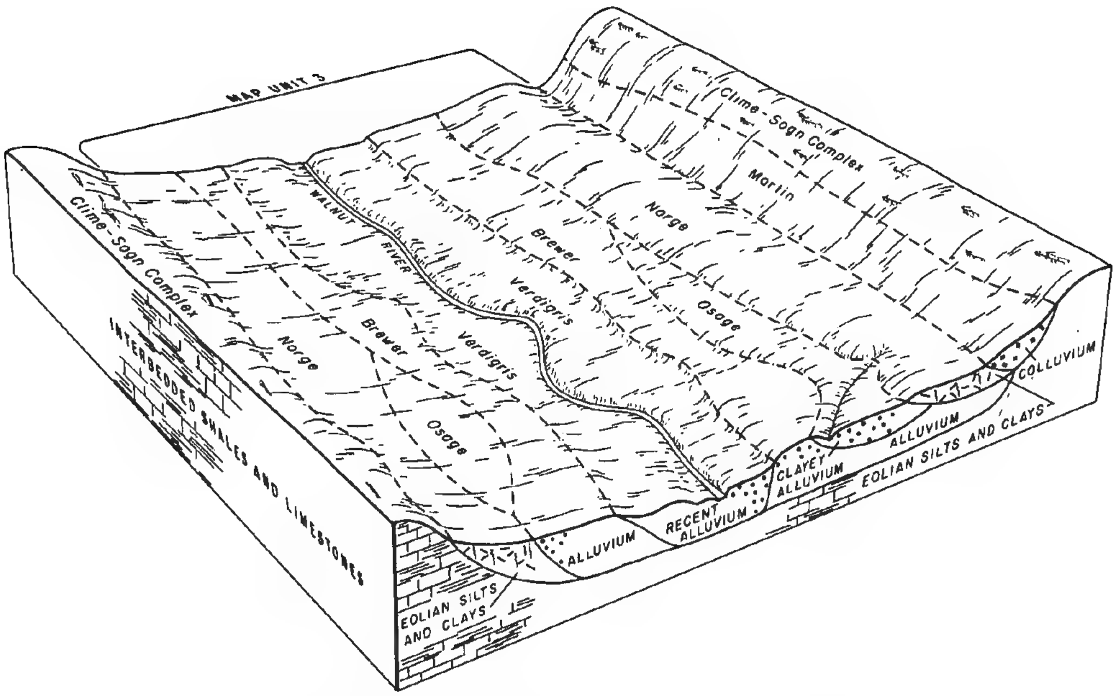


Figure 2.—Pattern of soils in Verdigris-Brewer-Norge map unit.

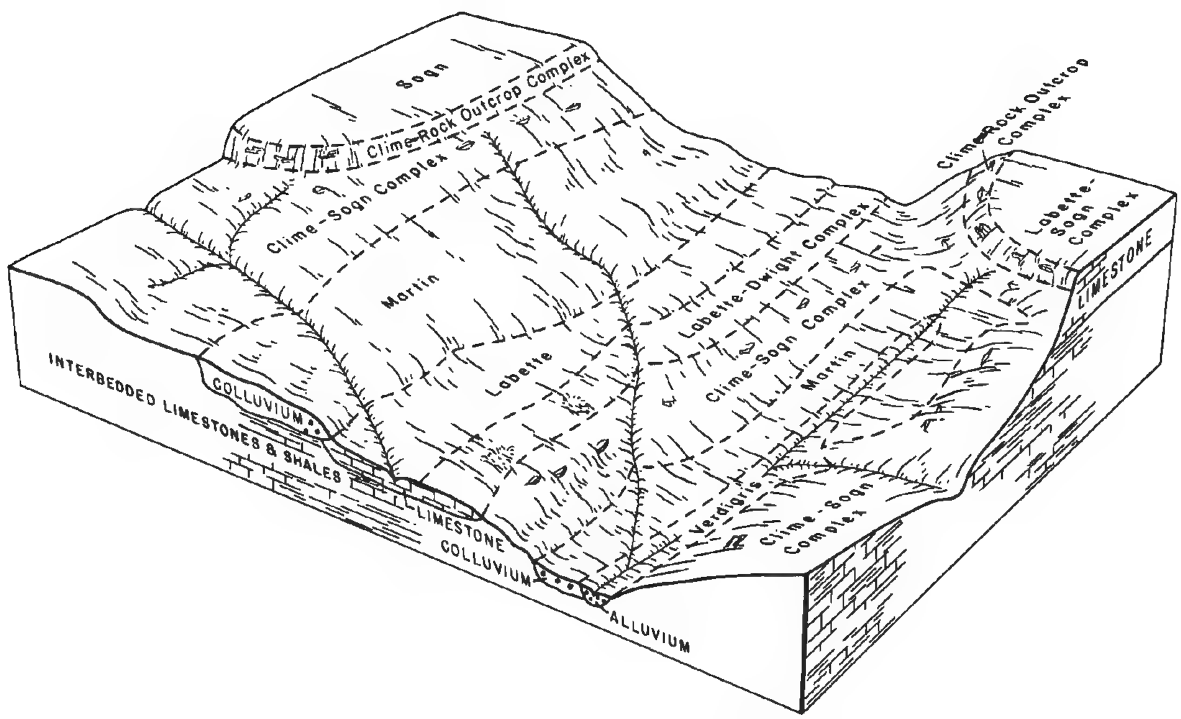


Figure 3.—Pattern of soils in Clime-Sogn-Martin map unit.

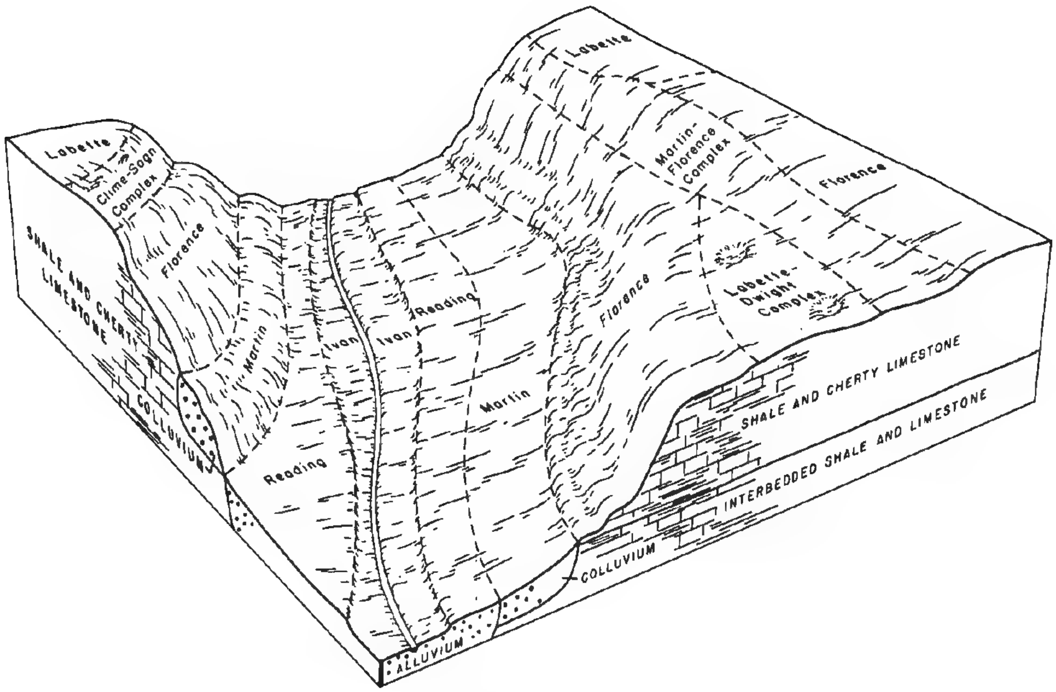


Figure 4.—Pattern of soils in Florence-Martin-Labette map unit.

Figure 5.—Grain sorghum, left, and alfalfa, right, planted on the contour on Bethany silt loam, 1 to 3 percent slopes.

Figure 6.—Landscape of Clime-Rock outcrop complex, 15 to 35 percent slopes.

Figure 7.—Wooded areas are common on Clime-Rock outcrop complex, 15 to 35 percent slopes.

Figure 8.—Flood retarding structure on Clime-Sogn complex, 2 to 15 percent slopes.

Figure 9.—Native grass range and stock pond on Florence cherty silt loam, 5 to 15 percent slopes.

Figure 10.—Cattle grazing bromegrass on Ivan silt loam along Silver Creek.

Figure 11.—Windrowed alfalfa, foreground, and grain sorghum on Reading silt loam. Trees, background, are on an Ivan silt loam along Grouse Creek.

Figure 12.—Cattle grazing bermudagrass on Verdigris silt loam along the Walnut River.

Figure 13.—A wooded area of Verdigris silt loam. Trees are mixed hardwoods.

Figure 14.—A field windbreak on Bethany silt loam. From left to right, the rows of trees are red cedar, hackberry, Siberian elm, American elm, and mulberry.

Figure 15.—Typical profile of Florence cherty silt loam, 5 to 15 percent slopes. High percent of angular chert fragments begins at depth of 1 foot.

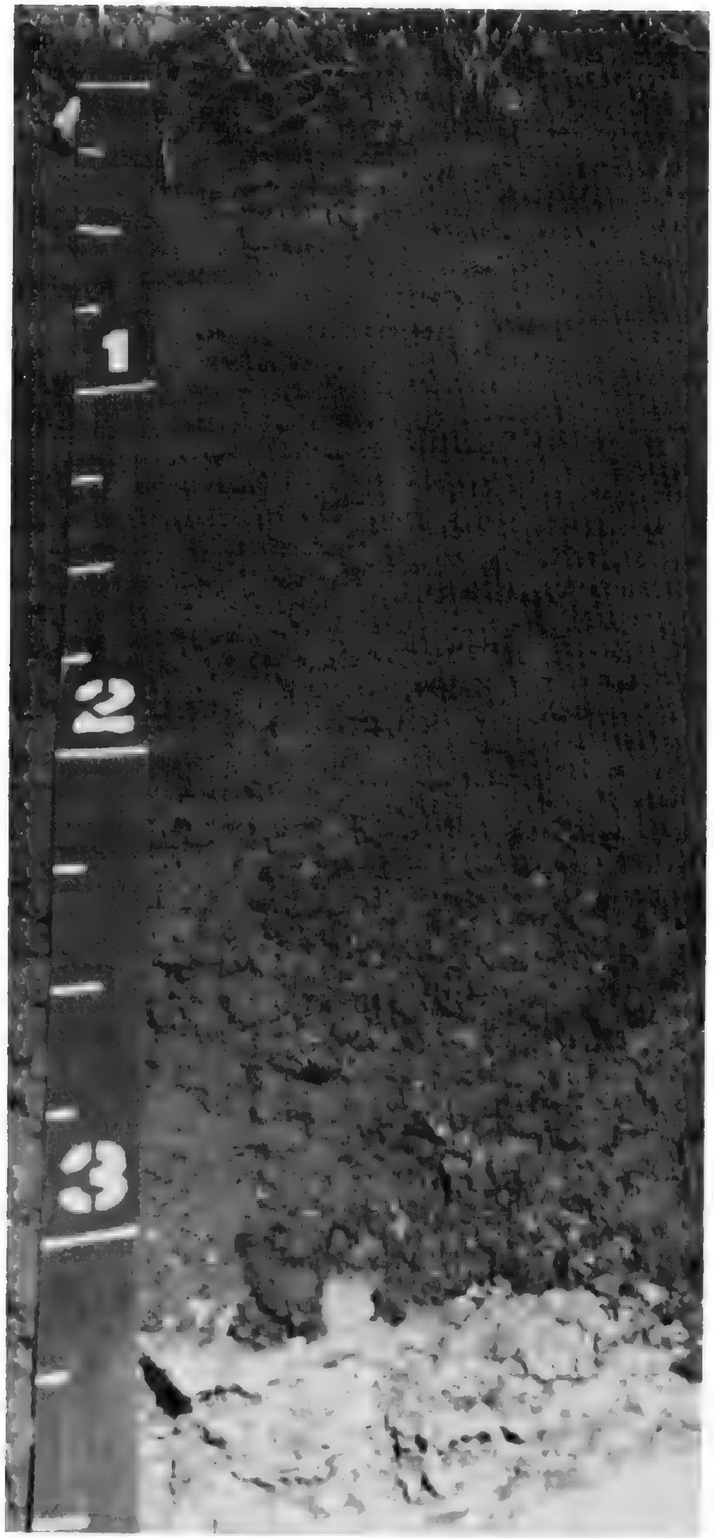


Figure 16.—Typical profile of Labette silty clay loam, 1 to 3 percent slopes. Depth to limestone is about 39 inches.

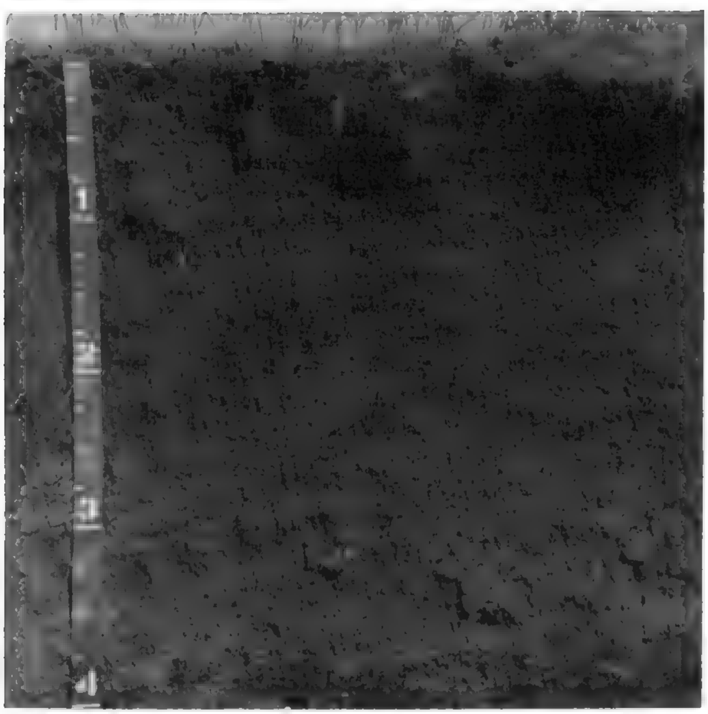


Figure 17.—Typical profile of Martin silty clay loam, 3 to 7 percent slopes. Note the strong blocky structure at 3 feet.

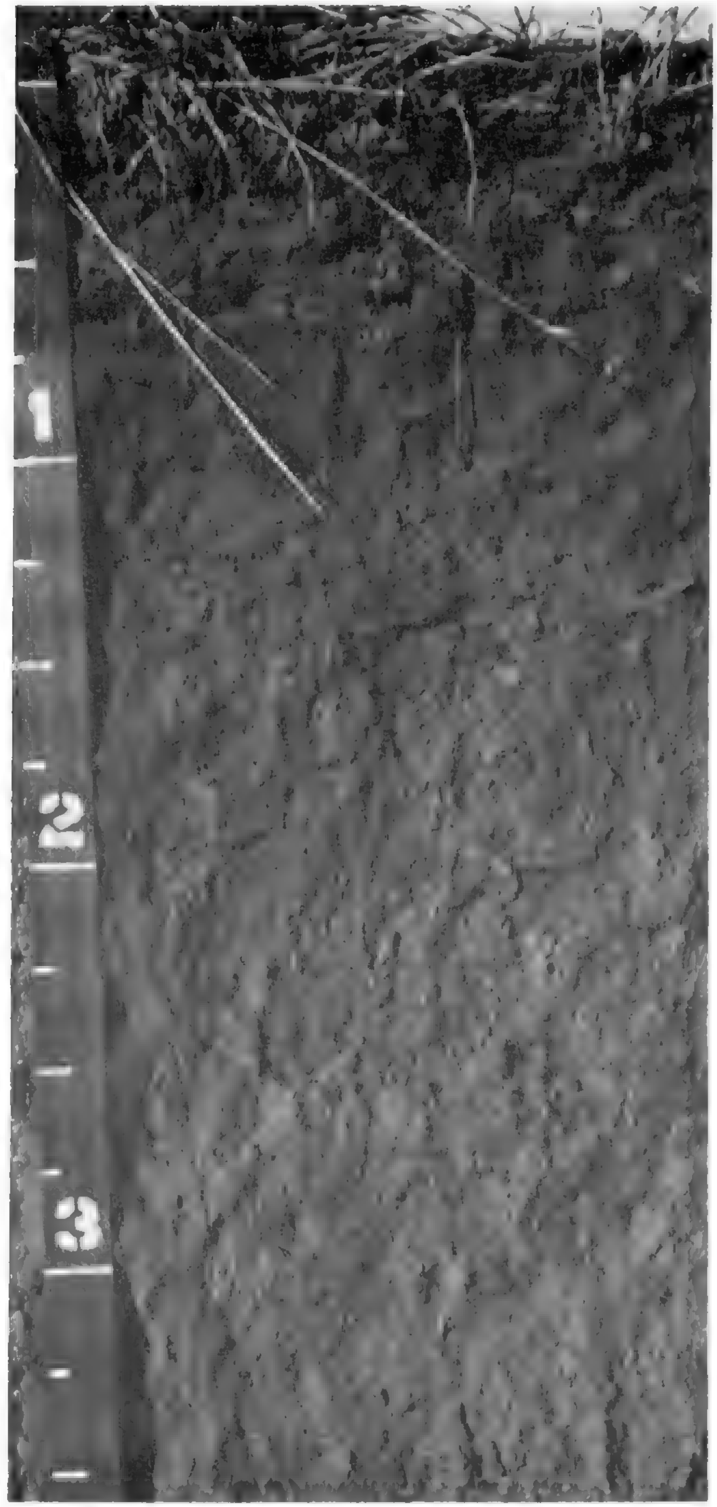


Figure 18.—Norge silt loam has dark colored surface layer. Note decrease in organic matter and lighter color at 12 inches.

Figure 19.—Typical profile of Olpe gravelly silt loam, 2 to 12 percent slopes. Eighty percent, by volume, of rounded chert between 2 and 4 feet.

Figure 20.—Typical profile of Sogn silty clay loam, 0 to 10 percent slopes. Depth to limestone is about 9 inches.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]					Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	Two years in 10 will have-- Maximum temperature higher than--	Two years in 10 will have-- Minimum temperature lower than--	Average	Two years in 10 will have-- Less than--	Two years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January	45.2	22.6	33.9	71	8	0.86	0.22	1.12	2	3.4
February	51.2	26.8	39.0	77	4	1.10	0.48	1.61	2	2.2
March	59.0	33.2	46.1	85	6	1.85	0.79	3.05	3	1.7
April	71.6	46.2	58.9	89	24	3.61	1.29	6.74	5	0.0
May	79.2	55.3	67.3	97	34	3.72	1.79	5.72	6	0.0
June	87.9	64.8	76.4	101	46	4.80	3.08	5.83	6	0.0
July	92.9	68.7	80.8	105	54	4.55	1.95	7.00	6	0.0
August	93.0	67.7	80.4	108	51	3.10	1.04	5.23	5	0.0
September	85.0	59.5	72.3	101	40	4.05	0.85	5.69	6	0.0
October	74.7	48.4	61.6	94	26	2.41	0.69	3.59	4	0.0
November	59.3	35.0	47.1	81	11	1.49	0.04	2.36	2	0.7
December	47.8	26.0	36.9	72	-2	1.31	0.38	1.84	3	2.4
Year	70.6	46.2	58.4	108	-8	32.85	23.65	41.81	50	10.4

[1]Recorded in the period 1941-70 at Winfield, Kansas.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 5	April 16	April 26
2 years in 10 later than--	March 31	April 11	April 21
5 years in 10 later than--	March 22	April 1	April 11
First freezing temperature in fall:			
1 year in 10 earlier than--	November 2	October 22	October 13
2 years in 10 earlier than--	November 6	October 27	October 17
5 years in 10 earlier than--	November 16	November 5	October 27

[1]Recorded in the period 1931-60 at Winfield, Kansas.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	217	198	178
8 years in 10	224	205	185
5 years in 10	239	218	199
2 years in 10	253	231	211
1 year in 10	261	247	218

[1]Recorded in the period 1931-60 at Winfield, Kansas.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Aa	Attica loamy fine sand, 3 to 6 percent slopes	3,100	0.4
Ab	Attica-Tivoli loamy fine sands, 3 to 15 percent slopes	1,400	0.2
Ba	Bethany silt loam, 0 to 1 percent slopes	7,800	1.1
Bb	Bethany silt loam, 1 to 3 percent slopes	11,800	1.6
Bc	Brewer silty clay loam	12,400	1.7
Ca	Canadian fine sandy loam	4,900	0.7
Cb	Clime-Rock outcrop complex, 15 to 35 percent slopes	17,700	2.4
Cc	Clime-Sogn complex, 2 to 15 percent slopes	69,000	9.5
Da	Dale silt loam	8,500	1.2
Db	Dwight silt loam	9,300	1.3
Fa	Florence cherty silt loam, 5 to 15 percent slopes	41,000	5.6
Ia	Irwin silty clay loam, 1 to 3 percent slopes	47,000	6.4
Ib	Ivan silt loam	11,700	1.6
La	Labette silty clay loam, 1 to 3 percent slopes	31,000	4.3
Lb	Labette silty clay loam, 3 to 7 percent slopes	7,500	1.0
Lc	Labette silty clay loam, 2 to 7 percent slopes, eroded	1,900	0.3
Ld	Labette-Dwight complex, 1 to 3 percent slopes	32,000	4.4
Le	Labette-Sogn silty clay loams, 2 to 8 percent slopes	60,000	8.0
Lf	Lesho clay loam	1,400	0.2
Lg	Lincoln-Tivoli complex, 0 to 10 percent slopes	4,900	0.7
Ma	Martin silty clay loam, 1 to 3 percent slopes	12,200	1.7
Mb	Martin silty clay loam, 3 to 7 percent slopes	36,400	5.0
Mc	Martin silty clay loam, 2 to 7 percent slopes, eroded	6,900	0.9
Md	Martin-Florence complex, 2 to 12 percent slopes	33,000	4.5
Me	Milan fine sandy loam, 1 to 5 percent slopes	3,176	0.4
Mf	Minco silt loam, 3 to 7 percent slopes	2,900	0.4
Mg	Minco silt loam, 7 to 15 percent slopes	2,400	0.3
Na	Norge silt loam, 1 to 3 percent slopes	20,400	2.8
Nb	Norge silt loam, 3 to 7 percent slopes	7,300	1.0
Nc	Norge silty clay loam, 3 to 7 percent slopes, eroded	3,400	0.5
Oa	Olpe gravelly silt loam, 2 to 12 percent slopes	1,500	0.2
Ob	Osage silty clay	2,600	0.4
Ra	Reading silt loam	5,100	0.7
Rb	Rosehill silty clay, 1 to 3 percent slopes	6,300	0.9
Rc	Rosehill silty clay, 3 to 6 percent slopes	2,600	0.4
Sa	Smolan silty clay loam, 1 to 3 percent slopes	31,300	4.3
Sb	Smolan silty clay loam, 3 to 7 percent slopes	8,200	1.1
Sc	Smolan silty clay loam, 3 to 7 percent slopes, eroded	4,700	0.6
Sd	Sogn silty clay loam, 0 to 10 percent slopes	51,000	7.0
Ta	Tabler silty clay loam, 0 to 1 percent slopes	13,800	1.9
Tb	Tabler silty clay loam, 1 to 3 percent slopes	10,800	1.5
Va	Vanoss silt loam, 0 to 1 percent slopes	4,200	0.6
Vb	Vanoss silt loam, 1 to 3 percent slopes	21,600	3.0
Vc	Vanoss silt loam, 3 to 7 percent slopes	7,100	1.0
Vd	Verdigris silt loam	40,300	5.5
Wa	Waurika silt loam	2,700	0.4
	Water areas	2,784	0.4
	Total	728,960	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Winter wheat	Grain sorghum	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Ton	AUM*
Aa-------------------------- Attica	28	45	3.0	5.0
Ab-------------------------- Attica-Tivoli	---	---	---	---
Ba-------------------------- Bethany	40	65	3.5	---
Bb-------------------------- Bethany	36	60	3.0	---
Bc-------------------------- Brewer	40	70	4.5	---
Ca-------------------------- Canadian	38	55	4.0	---
Cb-------------------------- Clime-Rock outcrop	---	---	---	---
Cc-------------------------- Clime-Sogn	---	---	---	---
Da-------------------------- Dale	40	70	5.0	---
Db-------------------------- Dwight	24	36	1.5	3.5
Fa-------------------------- Florence	---	---	---	---
Ia-------------------------- Irwin	34	50	3.0	5.0
Ib-------------------------- Ivan	38	65	4.5	7.0
La-------------------------- Labette	32	55	3.0	5.0
Lb-------------------------- Labette	28	50	2.6	4.5
Lc-------------------------- Labette	24	45	2.5	4.5
Ld-------------------------- Labette-Dwight	26	45	2.5	4.5
Le-------------------------- Labette-Sogn	---	---	---	---
Lf-------------------------- Lesho	24	40	2.7	5.5
Lg-------------------------- Lincoln	---	---	---	---
Ma-------------------------- Martin	36	60	3.5	5.5

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Winter wheat	Grain sorghum	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Ton	AUM*
Mb------------------------ Martin	32	55	3.2	5.5
Mc------------------------ Martin	28	45	2.6	4.5
Md------------------------ Martin-Florence	---	---	---	---
Me------------------------ Milan	32	55	3.0	5.0
Mf------------------------ Minco	30	50	5.5	---
Mg------------------------ Minco	---	---	---	---
Na------------------------ Norge	32	55	3.0	---
Nb------------------------ Norge	28	50	3.0	---
Nc------------------------ Norge	24	45	2.5	---
Oa------------------------ Olpe	---	---	---	---
Ob------------------------ Osage	30	55	2.0	---
Ra------------------------ Reading	44	75	4.5	6.5
Rb------------------------ Rosehill	30	43	1.8	---
Rc------------------------ Rosehill	27	40	1.4	---
Sa------------------------ Smolan	34	60	3.0	6.0
Sb------------------------ Smolan	30	55	2.5	5.2
Sc------------------------ Smolan	26	45	2.0	5.0
Sd------------------------ Sogn	---	---	---	---
Ta------------------------ Tabler	30	50	2.5	---
Tb------------------------ Tabler	28	45	2.0	---
Va------------------------ Vanoss	40	65	3.5	---
Vb------------------------ Vanoss	36	60	3.0	---
Vc------------------------ Vanoss	32	55	2.5	

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Winter wheat	Grain sorghum	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Ton	AUM*
Vd------------------------- Verdigris	40	70	5.5	---
Wa------------------------- Waurika	28	45	2.5	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Aa: Attica	Sandy	Favorable	5,500	Sand bluestem	30
		Normal	4,500	Big bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Sand lovegrass	5
Ab*:					
Attica	Sandy	Favorable	5,500	Sand bluestem	30
		Normal	4,500	Big bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Sand lovegrass	5
Tivoli	Sands	Favorable	4,000	Sand bluestem	35
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Big sandreed	10
				Big bluestem	10
				Switchgrass	10
				Indiangrass	5
				Sand lovegrass	5
Ba, Bb: Bethany	Loamy Upland	Favorable	5,000	Little bluestem	25
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Blue grama	5
				Tall dropseed	5
Bc: Brewer	Loamy Lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Switchgrass	15
		Unfavorable	4,200	Indiangrass	15
				Prairie cordgrass	10
				Little bluestem	5
				Western wheatgrass	5
				Canada wildrye	5
				Sedge	5
Ca: Canadian	Sandy Lowland	Favorable	8,500	Big bluestem	25
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Beaked panicum	5
				Sedge	5
Cb*:					
Clime	Breaks	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
Rock outcrop.					

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Cc*:					
Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	15
				Big bluestem	10
				Buffalograss	5
				Smooth sumac	5
Da Dale	Loamy Lowland	Favorable	8,500	Big bluestem	25
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Prairie cordgrass	5
				Eastern gamagrass	5
				Tall dropseed	5
				Sedge	5
Db Dwight	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Prairie dropseed	10
				Tall dropseed	10
				Heath aster	10
				Western wheatgrass	10
				Blue grama	8
				Switchgrass	5
				Sideoats grama	5
Fa Florence	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Little bluestem	30
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
Ia Irwin	Clay Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Ib Ivan	Loamy Lowland	Favorable	10,000	Big bluestem	35
		Normal	8,000	Indiangrass	20
		Unfavorable	6,000	Switchgrass	10
				Prairie cordgrass	5
				Eastern gamagrass	5
				Little bluestem	5
La, Lb, Lc Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10
Ld*:					
Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ld*:					
Dwight	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Prairie dropseed	10
				Tall dropseed	10
				Western wheatgrass	10
				Blue grama	5
				Switchgrass	5
				Sideoats grama	5
Le*:					
Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	20
				Switchgrass	10
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	15
				Big bluestem	10
				Buffalograss	5
				Smooth sumac	5
Lf Lesho	Subirrigated	Favorable	9,000	Sand bluestem	15
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Eastern gamagrass	10
				Switchgrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Tall dropseed	5
				Western wheatgrass	5
				Sedge	5
Lg*:					
Lincoln	Sandy Lowland	Favorable	4,000	Switchgrass	20
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	10
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
Tivoli	Sands	Favorable	4,000	Sand bluestem	35
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Big sandreed	10
				Big bluestem	10
				Switchgrass	10
				Indiangrass	5
				Sand lovegrass	5
Ma, Mb, Mc Martin	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Md*:					
Martin	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Md*: Florence	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Little bluestem	30
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
Me: Milan	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Mf, Mg: Minco	Loamy Upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Blue grama	5
				Tall dropseed	5
Na, Nb, Nc: Norge	Loamy Upland	Favorable	5,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Blue grama	5
				Tall dropseed	5
Oa: Olpe	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
Ob: Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	30
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Switchgrass	10
				Indiangrass	10
				Little bluestem	10
				Eastern gamagrass	5
				Eastern cottonwood	5
Ra: Reading	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Rb, Rc: Rosehill	Clay Upland	Favorable	6,500	Big bluestem	30
		Normal	4,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5
				Western wheatgrass	5
Sa, Sb, Sc: Smolan	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
				Western wheatgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Sd: Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	15
				Big bluestem	10
				Buffalograss	5
				Smooth sumac	5
Ta, Tb: Tabler	Clay Upland	Favorable	5,000	Little bluestem	20
		Normal	3,500	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Va, Vb, Vc: Vanoss	Loamy Upland	Favorable	5,500	Little bluestem	25
		Normal	4,500	Big bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Blue grama	5
				Tall dropseed	5
Vd: Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,500	Indiangrass	20
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Little bluestem	5
				Prairie cordgrass	5
Wa: Waurika	Clay Upland	Favorable	5,000	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	1,500	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
				Tall dropseed	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Aa: Attica	Lilac, cotoneaster, American plum.	Chokecherry, aromatic sumac.	Eastern redcedar, white mulberry, osageorange.	Green ash, Austrian pine, ponderosa pine.	Honeylocust, eastern cottonwood, sycamore.
Ab*:					
Attica	Lilac, cotoneaster, American plum.	Chokecherry, aromatic sumac.	Eastern redcedar, white mulberry, osageorange.	Green ash, Austrian pine, ponderosa pine.	Honeylocust, eastern cottonwood, sycamore.
Tivoli.					
Ba, Bb: Bethany	Lilac, aromatic sumac, American plum.	Autumn-olive, Amur maple.	Green ash, hackberry, bur oak.	Honeylocust	---
Bc: Brewer	Lilac, aromatic sumac.	Chokecherry	Eastern redcedar, osageorange.	---	Green ash, eastern cottonwood.
Ca: Canadian	Lilac, aromatic sumac.	---	Hackberry	Eastern redcedar, Austrian pine, Siberian elm, honeylocust, green ash.	Eastern cottonwood, sycamore.
Cb*:					
Clime	Lilac, American plum, aromatic sumac.	---	Eastern redcedar, ponderosa pine, Siberian elm, osageorange, Russian-olive.	---	---
Rock outcrop.					
Cc*:					
Clime	Lilac, American plum, aromatic sumac.	---	Eastern redcedar, ponderosa pine, Siberian elm, osageorange, Russian-olive.	---	---
Sogn.					
Da: Dale	Lilac, aromatic sumac, chokecherry, cotoneaster.	Autumn-olive, Amur honeysuckle, redbud.	Crabapple, white mulberry.	Eastern redcedar, Austrian pine, honeylocust.	Green ash, eastern cottonwood, sycamore.
Db: Dwight	Aromatic sumac, buffaloberry.	Russian-olive	Eastern redcedar, Siberian elm, osageorange.	---	Eastern cottonwood.
Fa. Florence					
Ia: Irwin	Aromatic sumac, Siberian peashrub.	Rocky Mountain juniper.	Siberian elm, osageorange, ponderosa pine, eastern redcedar.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ib Ivan	Lilac, aromatic sumac, cotoneaster.	Autumn-olive, Amur honeysuckle.	Russian-olive, silver maple.	Honeylocust, Siberian elm.	Sycamore, eastern cottonwood.
La, Lb, Lc Labette	Lilac, aromatic sumac, American plum.	Russian-olive, chokecherry.	Common hackberry, green ash.	Eastern redcedar, Austrian pine, Siberian elm.	---
Ld*: Labette	Lilac, aromatic sumac, American plum.	Russian-olive, chokecherry.	Common hackberry, green ash.	Eastern redcedar, Austrian pine, Siberian elm.	---
Dwight	Lilac, aromatic sumac, American plum.	Russian-olive	Eastern redcedar, osageorange.	Siberian elm, golden willow.	Eastern cottonwood.
Le*: Labette	Lilac, aromatic sumac, American plum.	Russian-olive	Eastern redcedar, common hackberry, green ash.	Siberian elm	---
Sogn.					
Lf Lesho	American plum, redosier dogwood.	Chokecherry, autumn-olive.	Eastern redcedar, ponderosa pine, Russian-olive, redbud.	Honeylocust, silver maple, sycamore.	Eastern cottonwood, baldcypress.
Lg*: Lincoln.	Aromatic sumac	Russian-olive	Eastern redcedar, hackberry, green ash.	Austrian pine, Scotch pine.	Eastern cottonwood.
Tivoli.					
Ma, Mb, Mc Martin	Lilac, aromatic sumac, autumn-olive.	Russian-olive, redbud.	Common hackberry, redcedar, Austrian pine.	Green ash	---
Md*: Martin	Lilac, aromatic sumac, autumn-olive.	Russian-olive, redbud.	Common hackberry, redcedar, Austrian pine.	Green ash	---
Florence.					
Me Milan	Honeysuckle, cotoneaster, lilac, aromatic sumac.	White mulberry, autumn-olive, Amur maple.	Common hackberry, honeylocust, osageorange.	Austrian pine, eastern redcedar.	---
Mf, Mg Minco	Honeysuckle, cotoneaster, lilac, aromatic sumac.	White mulberry, autumn-olive, Amur maple.	Common hackberry, honeylocust, osageorange.	Austrian pine, eastern redcedar.	---
Na, Nb, Nc Norge	Honeysuckle, cotoneaster, lilac, aromatic sumac.	White mulberry, autumn-olive, Amur maple.	Common hackberry, honeylocust, osageorange.	Eastern redcedar, Austrian pine.	---
Oa. Olpe					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ob: Osage	Lilac, American plum, coton-easter.	Tatarian honeysuckle, Amur honeysuckle, redosier dogwood.	Medium purple willow, redbud, eastern redcedar.	Green ash, honeylocust, silver maple.	Oriental arborvitae, baldcypress.
Ra: Reading	Lilac, American plum, coton-easter.	American plum	Eastern redcedar, silver maple, Russian-olive.	Siberian elm, honeylocust, Austrian pine.	Eastern cottonwood, sycamore.
Rb, Rc: Rosehill	Lilac, American plum, coton-easter.	Osageorange, white mulberry, Russian-olive.	Eastern redcedar, common hackberry, Siberian elm.	Austrian pine, green ash.	---
Sa, Sb, Sc: Smolan	Lilac, Amur honey-suckle, coton-easter, American plum.	Autumn olive, Amur maple, winterberry euonymus.	Eastern redcedar, osageorange, Austrian pine, bur oak, hackberry.	Honeylocust	Siberian elm.
Sd. Sogn					
Ta, Tb: Tabler	Lilac, aromatic sumac, choke-cherry, autumn olive.	Russian-olive	Eastern redcedar, hackberry, pin oak.	Austrian pine, green ash.	---
Va, Vb, Vc: Vanoss	Lilac, Amur honey-suckle, Peking cotoneaster, American plum.	Autumn-olive, Amur maple, winterberry euonymus.	Eastern redcedar, bur oak, green ash, oriental arborvitae.	Austrian pine, Scotch pine.	---
Vd: Verdigris	Aromatic sumac	American plum, autumn-olive, Amur honeysuckle, chokecherry, redbud.	Austrian pine, Russian-olive, Washington hawthorne.	Siberian elm, honeylocust, silver maple, green ash.	Sycamore, eastern cottonwood.
Wa: Waurika	Lilac, aromatic sumac, choke-cherry, autumn-olive.	Russian-olive	Eastern redcedar, hackberry, pin oak.	Austrian pine, green ash.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Aa: Attica	Slight	Slight	Slight	Moderate: slope.	Slight.
Ab*:					
Attica	Slight	Slight	Slight	Moderate: slope.	Slight.
Tivoli	Severe: cutbanks cave, too sandy.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Ba, Bb: Bethany	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Bc: Brewer	Moderate: too clayey.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: shrink-swell, low strength.
Ca: Canadian	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
Cb*:					
Clime	Severe: slope.	Severe: slope, low strength.	Severe: slope, low strength.	Severe: low strength, slope.	Severe: low strength, slope.
Rock outcrop.					
Cc*:					
Clime	Moderate: too clayey, slope.	Severe: low strength.	Severe: low strength.	Severe: low strength, slope.	Severe: low strength.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Da: Dale	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: low strength, shrink-swell, floods.
Db: Dwight	Moderate: too clayey, depth to rock.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Fa: Florence	Moderate: large stones, too clayey.	Moderate: large stones, low strength, slope.	Moderate: large stones, low strength, slope.	Severe: slope.	Moderate: large stones, low strength.
Ia: Irwin	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Ib: Ivan	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
La, Lb, Lc: Labette	Severe: depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell, depth to rock, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Ld*:					
Labette	Severe: depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell, depth to rock, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Dwight	Moderate: too clayey, depth to rock.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Le*:					
Labette	Severe: depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell, depth to rock, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Lf: Lesho	Severe: floods, wetness.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.
Lg*:					
Lincoln	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Tivoli	Severe: cutbanks cave, too sandy.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Ma, Mb, Mc: Martin	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Md*:					
Martin	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Florence	Moderate: large stones, too clayey.	Moderate: large stones, low strength, slope.	Moderate: large stones, low strength, slope.	Moderate: large stones, low strength.	Moderate: large stones, low strength.
Me: Milan	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Mf: Minco	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength, slope.	Moderate: low strength.
Mg: Minco	Moderate: slope.	Moderate: low strength, slope.	Moderate: low strength, slope.	Severe: slope.	Moderate: low strength, slope.
Na: Norge	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Nb, Nc Norge	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell, slope.	Severe: low strength.
Oa Olpe	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
Ob Osage	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: wetness, low strength, floods.
Ra Reading	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Rb, Rc Rosehill	Moderate: too clayey, depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Sa, Sb, Sc Smolan	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Sd Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Ta, Tb Tabler	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Va, Vb, Vc Vanoss	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength, shrink-swell.
Vd Verdigris	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.
Wa Waurika	Severe: wetness.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.

* See description of tne map unit for composition and behavior characteristics of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Aa: Attica	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Ab*:					
Attica	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Tivoli	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Ba, Bb: Bethany	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
Bc: Brewer	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: floods.	Poor: too clayey.
Ca: Canadian	Moderate: floods.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Cb*:					
Clime	Severe: percs slowly, depth to rock, slope.	Severe: slope.	Severe: too clayey, depth to rock.	Severe: slope.	Poor: too clayey, slope, area reclaim.
Rock outcrop.					
Cc*:					
Clime	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Da: Dale	Moderate: floods.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Db: Dwight	Severe: percs slowly.	Moderate: depth to rock.	Severe: too clayey, depth to rock.	Slight	Fair: hard to pack, area reclaim.
Fa: Florence	Severe: percs slowly, depth to rock.	Severe: large stones, slope.	Severe: too clayey, depth to rock.	Moderate: slope.	Poor: too clayey, small stones, large stones.
Ia: Irwin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Ib: Ivan	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
La, Lb, Lc: Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ld*:					
Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Dwight	Severe: percs slowly.	Moderate: slope, depth to rock.	Severe: too clayey, depth to rock.	Slight	Fair: hard to pack, area reclaim.
Le*:					
Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Lf Lesho	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Fair: too clayey.
Lg*:					
Lincoln	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
Tivoli	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Ma, Mb, Mc Martin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Md*:					
Martin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Florence	Severe: percs slowly, depth to rock.	Severe: large stones.	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, small stones, large stones.
Me Milan	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
Mf Minco	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Mg Minco	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Na, Nb Norge	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Nc Norge	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Oa Olpe	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: small stones.
Ob Osage	Severe: floods, percs slowly, wetness.	Severe: floods.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ra: Reading	Severe: percs slowly.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Rb, Rc: Rosehill	Severe: percs slowly, depth to rock.	Moderate: depth to rock, slope.	Severe: too clayey, depth to rock.	Moderate: depth to rock.	Poor: too clayey, area reclaim.
Sa, Sb, Sc: Smolan	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Sd: Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ta: Tabler	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Moderate: wetness.	Poor: too clayey.
Tb: Tabler	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey.
Va, Vb, Vc: Vanoss	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Vd: Verdigris	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Wa: Waurika	Severe: percs slowly, wetness.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Aa: Attica	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy.
Ab*:				
Attica	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy.
Tivoli	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Ba, Bb: Bethany	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Bc: Brewer	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Ca: Canadian	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Cb*:				
Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, slope.
Rock outcrop.				
Cc*:				
Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Sogn	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Da: Dale	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Db: Dwight	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Fa: Florence	Poor: low strength, large stones.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones, large stones.
Ia: Irwin	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Ib: Ivan	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
La, Lb, Lc: Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ld*:				
Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.
Dwight	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Le*:				
Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.
Sogn	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
Lf Lesho	Fair: low strength, wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Lg*:				
Lincoln	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Tivoli	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Ma, Mb, Mc Martin	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Md*:				
Martin	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Florence	Poor: low strength, large stones.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones, large stones.
Me Milan	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Mf Minco	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Mg Minco	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
Na, Nb Norge	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Nc Norge	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Oa Olpe	Fair: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones.
Ob Osage	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, wetness.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ra: Reading	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Rb, Rc: Rosehill	Poor: low strength, shrink-swell, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Sa, Sb, Sc: Smolan	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Sd: Sogn	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Ta, Tb: Tabler	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Va, Vb, Vc: Vanoss	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Vd: Verdigris	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Wa: Waurika	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Aa: Attica	Seepage	Favorable	Not needed	Fast intake, soil blowing.	Soil blowing	Favorable.
Ab*:						
Attica	Seepage	Favorable	Not needed	Fast intake, soil blowing.	Soil blowing	Favorable.
Tivoli	Seepage	Seepage, piping.	Not needed	Slope, erodes easily, droughty, soil blowing.	Soil blowing, erodes easily.	Droughty.
Ba, Bb: Bethany	Favorable	Hard to pack	Not needed	Erodes easily, percs slowly.	Percs slowly	Percs slowly.
Bc: Brewer	Favorable	Hard to pack	Not needed	Erodes easily, percs slowly.	Percs slowly	Percs slowly.
Ca: Canadian	Seepage	Favorable	Not needed	Soil blowing	Soil blowing	Favorable.
Cb*:						
Clime	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Percs slowly, rooting depth, slope.	Slope, percs slowly.	Slope, depth to rock, percs slowly.
Rock outcrop.						
Cc*:						
Clime	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Percs slowly, rooting depth, slope.	Percs slowly	Slope, depth to rock, percs slowly.
Sogn	Slope, depth to rock.	Thin layer	Not needed	Droughty, rooting depth, slope.	Depth to rock	Droughty, rooting depth.
Da: Dale	Seepage	Piping	Not needed	Favorable	Not needed	Favorable.
Db: Dwight	Depth to rock	Piping, hard to pack, thin layer.	Excess sodium	Percs slowly, excess sodium.	Percs slowly	Percs slowly, excess sodium.
Fa: Florence	Slope, depth to rock.	Thin layer, large stones.	Not needed	Slope, large stones, droughty.	Large stones	Large stones, slope, droughty.
Ia: Irwin	Depth to rock	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Ib: Ivan	Seepage	Favorable	Not needed	Floods	Not needed	Favorable.
La, Lb, Lc: Labette	Depth to rock	Thin layer, hard to pack.	Not needed	Percs slowly, rooting depth, erodes easily.	Large stones, percs slowly.	Erodes easily, depth to rock.
Ld*:						
Labette	Depth to rock	Thin layer, hard to pack.	Not needed	Percs slowly, rooting depth, erodes easily.	Large stones, percs slowly.	Erodes easily, depth to rock.
Dwight	Depth to rock	Piping, hard to pack, thin layer.	Excess sodium	Percs slowly, excess sodium.	Percs slowly	Percs slowly. excess sodium.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Le*:						
Labette	Depth to rock	Thin layer, hard to pack.	Not needed	Percs slowly, rooting depth, erodes easily.	Large stones, depth to rock, percs slowly.	Erodes easily, depth to rock.
Sogn	Depth to rock	Thin layer	Not needed	Rooting depth, droughty.	Depth to rock	Droughty, rooting depth.
Lf-Lesho	Seepage	Seepage, piping.	Floods	Floods, wetness.	Not needed	Favorable.
Lg*:						
Lincoln	Seepage	Seepage, piping.	Floods	Floods, seepage, droughty.	Not needed	Droughty.
Tivoli	Seepage	Seepage, piping.	Not needed	Erodes easily, droughty, soil blowing.	Soil blowing, erodes easily.	Droughty.
Ma, Mb, Mc-Martin	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Md*:						
Martin	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily, slope.	Percs slowly	Erodes easily, percs slowly.
Florence	Slope, depth to rock.	Thin layer, large stones.	Not needed	Slope, large stones, droughty.	Large stones	Large stones, droughty.
Me-Milan	Favorable	Favorable	Not needed	Soil blowing	Soil blowing	Favorable.
Mf-Minco	Seepage	Piping	Not needed	Erodes easily	Favorable	Erodes easily.
Mg-Minco	Seepage	Piping	Not needed	Slope, erodes easily.	Favorable	Slope, erodes easily.
Na, Nb, Nc-Norge	Favorable	Piping	Not needed	Erodes easily	Favorable	Erodes easily.
Oa-Olpe	Slope	Favorable	Not needed	Droughty, percs slowly, slope.	Percs slowly	Percs slowly.
Ob-Osage	Favorable	Wetness, hard to pack.	Floods, percs slowly.	Wetness, slow intake, percs slowly.	Not needed	Percs slowly, wetness.
Ra-Reading	Favorable	Favorable	Not needed	Favorable	Not needed	Favorable.
Rb, Rc-Rosehill	Depth to rock	Thin layer, hard to pack.	Not needed	Slow intake, rooting depth, percs slowly.	Percs slowly	Depth to rock, percs slowly.
Sa, Sb, Sc-Smolan	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Sd-Sogn	Depth to rock	Thin layer	Not needed	Rooting depth, droughty.	Depth to rock	Droughty, rooting depth.
Ta, Tb-Tabler	Favorable	Hard to pack	Percs slowly	Percs slowly	Percs slowly	Percs slowly.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Va, Vb, Vc Vanoss	Seepage	Piping	Not needed	Favorable	Favorable	Favorable.
Vd Verdigris	Seepage	Piping	Not needed	Floods	Not needed	Favorable.
Wa Waurika	Favorable	Wetness	Percs slowly	Wetness, percs slowly.	Not needed	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Aa: Attica	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Ab*:				
Attica	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Tivoli	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.
Ba, Bb: Bethany	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Bc: Brewer	Severe: floods.	Slight	Moderate: too clayey, percs slowly.	Moderate: too clayey.
Ca: Canadian	Severe: floods.	Slight	Slight	Slight.
Cb*:				
Clime	Severe: slope, too clayey.	Severe: slope.	Severe: slope, too clayey.	Moderate: too clayey, slope.
Rock outcrop.				
Cc*:				
Clime	Severe: too clayey.	Moderate: slope, too clayey.	Severe: slope, too clayey.	Moderate: too clayey.
Sogn	Severe: depth to rock.	Moderate: slope.	Severe: depth to rock, slope.	Slight.
Da: Dale	Severe: floods.	Slight	Slight	Slight.
Db: Dwight	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Fa: Florence	Severe: small stones.	Severe: small stones.	Severe: small stones, slope.	Severe: small stones.
Ia: Irwin	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
Ib: Ivan	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
La, Lb, Lc: Labette	Moderate: too clayey.	Slight	Moderate: depth to rock, slope.	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ld*:				
Labette	Moderate: too clayey.	Slight	Moderate: depth to rock, slope.	Slight.
Dwight	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
Le*:				
Labette	Moderate: too clayey.	Slight	Moderate: depth to rock, slope.	Slight.
Sogn	Severe: depth to rock.	Slight	Severe: depth to rock.	Slight.
Lf Lesho	Severe: floods.	Slight	Moderate: wetness, floods.	Slight.
Lg*:				
Lincoln	Severe: floods.	Slight	Moderate: floods.	Slight.
Tivoli	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
Ma, Mb, Mc Martin	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
Md*:				
Martin	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
Florence	Severe: small stones.	Severe: small stones.	Severe: small stones, slope.	Severe: small stones.
Me Milan	Slight	Slight	Moderate: slope.	Slight.
Mf Minco	Slight	Slight	Moderate: slope.	Slight.
Mg Minco	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Na, Nb Norge	Slight	Slight	Moderate: slope.	Slight.
Nc Norge	Moderate: too clayey.	Slight	Moderate: too clayey.	Slight.
Oa Olpe	Moderate: percs slowly, small stones.	Moderate: small stones.	Severe: slope, percs slowly, small stones.	Moderate: small stones.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ob: Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey.	Severe: too clayey, wetness, floods.	Severe: too clayey.
Ra: Reading	Severe: floods.	Slight	Slight	Slight.
Rb, Rc: Rosehill	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: too clayey.	Moderate: too clayey.
Sa, Sb, Sc: Smolan	Moderate: too clayey.	Slight	Moderate: slope, too clayey.	Slight.
Sd: Sogn	Severe: depth to rock.	Slight	Severe: depth to rock.	Slight.
Ta, Tb: Tabler	Moderate: percs slowly.	Slight	Moderate: percs slowly, too clayey.	Slight.
Va: Vanoss	Slight	Slight	Slight	Slight.
Vb: Vanoss	Slight	Slight	Moderate: slope.	Slight.
Vc: Vanoss	Slight	Slight	Moderate: slope.	Slight.
Vd: Verdigris	Severe: floods.	Slight	Moderate: floods.	Slight.
Wa: Waurika	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Aa-------- Attica	Poor	Fair	Good	Fair	Fair	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Ab*:												
Attica----------	Poor	Fair	Good	Fair	Fair	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Tivoli----------	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.
Ba, Bb---------- Bethany	Good	Good	Fair	Fair	Fair	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
Bc-------- Brewer	Good	Good	Fair	Good	Good	Good	Poor	Poor	Good	Good	Poor	Fair.
Ca-------- Canadian	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Cb*:												
Clime----------	Fair	Fair	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Rock outcrop.												
Cc*:												
Clime----------	Fair	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Sogn----------	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Da-------- Dale	Good	Good	Fair	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Db-------- Dwight	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Fair	Fair	---	Poor	Fair.
Fa-------- Florence	Poor	Good	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Ia-------- Irwin	Good	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	---	Poor	Fair.
Ib-------- Ivan	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	---
La, Lb, Lc---------- Labette	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	---	Poor	Fair.
Ld*:												
Labette----------	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	---	Poor	Fair.
Dwight----------	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Fair	Fair	---	Poor	Fair.
Le*:												
Labette----------	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	---	Poor	Fair.
Sogn----------	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Lf-------- Lesho	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Lg*:												
Lincoln	Poor	Fair	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Tivoli	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.
Ma Martin	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	---	Poor	Good.
Mb Martin	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Mc Martin	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	---	Poor	Good.
Md*:												
Martin	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Florence	Poor	Good	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Me Milan	Fair	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
Mf Minco	Fair	Good	Good	Good	Fair	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Mg Minco	Fair	Good	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.
Na Norge	Good	Good	Fair	Good	Fair	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
Nb, Nc Norge	Fair	Good	Fair	Good	Fair	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Oa Olpe	Fair	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
Ob Osage	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair	---
Ra Reading	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Rb, Rc Rosehill	Fair	Good	Fair	Poor	Poor	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Sa Smolan	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	---	Poor	Fair.
Sb, Sc Smolan	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Sd Sogn	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Ta, Tb Tabler	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	---	Poor	Fair.
Va, Vb, Vc Vanoss	Good	Good	Good	Good	Fair	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Vd Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Wa------------------ Waurika	Fair	Good	Fair	Poor	Poor	Fair	Fair	Fair	Fair	---	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Aa-----------------Attica	0-9	Loamy fine sand	SM	A-2	0	100	95-100	70-100	12-35	---	NP*
	9-20	Fine sandy loam, sandy loam.	SM, ML, SM-SC, CL-ML	A-2, A-4	0	100	95-100	75-100	30-55	<26	NP-6
	20-60	Fine sandy loam, loamy fine sand.	SM, SM-SC	A-2, A-4	0	100	95-100	70-100	20-50	<26	NP-6
Ab**:											
Attica------------	0-9	Loamy fine sand	SM	A-2	0	100	95-100	70-100	12-35	---	NP
	9-20	Fine sandy loam, sandy loam.	SM, ML, SM-SC, CL-ML	A-2, A-4	0	100	95-100	75-100	30-55	<26	NP-6
	20-60	Fine sandy loam, loamy fine sand.	SM, SM-SC	A-2, A-4	0	100	95-100	70-100	20-50	<26	NP-6
Tivoli------------	0-7	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-100	5-35	---	NP
	7-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-98	5-20	---	NP
Ba, Bb-------------Bethany	0-9	Silt loam--------	CL, ML	A-4, A-6	0	100	100	96-100	80-98	21-40	1-15
	9-16	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-50	15-26
	16-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	100	95-100	96-100	90-99	37-60	15-33
Bc-----------------Brewer	0-15	Silty clay loam	CL, ML	A-4, A-6, A-7	0	100	100	96-100	80-98	30-43	8-19
	15-42	Silty clay loam, silty clay, clay loam.	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	16-38
	42-60	Silty clay loam, loam, clay loam.	CL, CH, ML	A-4, A-6, A-7	0	100	100	96-100	80-98	30-70	8-38
Ca-----------------Canadian	0-28	Fine sandy loam	SM, ML, SC, CL	A-4	0	100	98-100	94-100	36-85	<31	NP-10
	28-60	Fine sandy loam, loam, sandy loam.	SM, ML, SC, CL	A-4, A-2	0	100	98-100	90-100	15-85	<31	NP-10
Cb**:											
Clime-------------	0-8	Silty clay-------	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	8-20	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	20-36	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Cc**:											
Clime-------------	0-8	Silty clay-------	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	8-20	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	20-36	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn--------------	0-10	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Da------------------ Dale	0-42	Silt loam--------	CL	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	8-20
	42-60	Silt loam, loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	8-20
Db------------------ Dwight	0-5	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	5-28	Clay, silty clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	28-54	Clay, silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	90-100	45-60	25-40
	54	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Fa------------------ Florence	0-14	Cherty silt loam	GC, SC, CL	A-6, A-2-6	10-40	30-90	25-90	20-85	20-85	25-35	11-20
	14-17	Cherty silty clay, cherty clay, cherty silty clay loam.	GC, SC, CH	A-2-7, A-7	10-85	30-70	25-65	20-60	15-55	51-65	30-40
	17-45	Coarse cherty clay, cherty clay.	GC, SC, CH	A-2-7, A-7	50-85	30-70	25-65	20-60	15-55	51-65	30-40
	45	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ia------------------ Irwin	0-13	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	11-20
	13-40	Silty clay, clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	40-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	95-100	90-100	40-60	20-40
Ib------------------ Ivan	0-28	Silt loam--------	CL	A-4, A-6, A-7	0	95-100	95-100	90-100	75-100	30-45	8-20
	28-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6, A-7	0	95-100	95-100	90-100	65-100	30-45	8-20
La, Lb, Lc---------- Labette	0-7	Silty clay loam	CL, ML	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	7-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ld**:											
Labette------------	0-7	Silty clay loam	CL, ML	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	7-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dwight-------------	0-5	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	5-28	Clay, silty clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	28-54	Clay, silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	90-100	45-60	25-40
	54	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Le**:											
Labette----------	0-7	Silty clay loam	CL, ML	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	7-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn--------------	0-10	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lf---------------- Lesho	0-24	Clay loam, loam	CL, ML	A-6, A-4, A-7-6	0	100	100	95-100	65-85	30-45	8-25
	24-60	Loamy fine sand, sand, coarse sand.	SM, SP-SM	A-2, A-3, A-4, A-1	0	100	100	30-85	5-45	---	NP
Lg**:											
Lincoln-----------	0-9	Fine sandy loam	SM, ML, CL, SC	A-4, A-6	0	90-100	85-100	75-100	36-95	<40	NP-20
	9-60	Fine sand, loamy fine sand.	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
Tivoli------------	0-7	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-100	5-35	---	NP
	7-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-98	5-20	---	NP
Ma, Mb, Mc--------- Martin	0-15	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	15-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40
Md**:											
Martin------------	0-15	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	15-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40
Florence----------	0-14	Cherty silt loam	GC, SC, CL	A-6, A-2-6	10-40	30-90	25-90	20-85	20-85	25-35	11-20
	14-17	Cherty silty clay, cherty clay, cherty silty clay loam.	GC, SC, CH	A-2-7, A-7	10-85	30-70	25-65	20-60	15-55	51-65	30-40
	17-45	Coarse cherty clay, cherty clay.	GC, SC, CH	A-2-7, A-7	50-85	30-70	25-65	20-60	15-55	51-65	30-40
	45	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Me---------------- Milan	0-9	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	95-100	95-100	80-100	35-55	<26	NP-5
	9-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, CH, MH, SM, ML	A-4, A-6 A-7-6	0	95-100	95-100	65-100	45-80	32-52	11-25
Mf, Mg------------ Minco	0-42	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	94-100	51-97	<31	NP-10
	42-60	Loam, silt loam, fine sandy loam.	ML, CL, CL-ML, SM, SC, SC-SM	A-4	0	100	98-100	94-100	36-97	<31	NP-10
Na, Nb------------ Norge	0-8	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	22-35	2-15
	8-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	75-98	33-43	12-20
Nc---------------- Norge	0-18	Silty clay loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	22-35	2-15
	18-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	75-98	33-43	12-20

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Oa----------------- Olpe	0-10	Gravelly silt loam.	GC, SC	A-2, A-4, A-6	0	30-65	25-60	20-55	15-50	20-30	7-15
	10-22	Gravelly silty clay loam, gravelly silty clay.	GC, SC	A-2, A-6, A-7	0	30-65	25-60	20-55	15-50	25-45	11-22
	22-60	Gravelly silty clay, gravelly clay, gravelly silty clay loam.	GC, SC	A-2-7, A-7	0	30-65	25-60	20-55	15-50	40-60	25-40
Ob----------------- Osage	0-18	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	18-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	50-80	30-55
Ra----------------- Reading	0-14	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	14-50	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
	50-60	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	80-100	35-50	15-30
Rb, Rc------------ Rosehill	0-8	Silty clay-------	CH, CL	A-7	0	100	100	95-100	90-100	45-70	30-50
	8-37	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	90-100	45-70	30-50
	37-46	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sa, Sb, Sc--------- Smolan	0-15	Silty clay loam	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	15-40	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	30-60	20-40
	40-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	30-60	10-35
Sd----------------- Sogn	0-10	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ta, Tb------------ Tabler	0-8	Silty clay loam	CL, ML, CL-ML	A-4, A-6	0	100	100	96-100	80-98	20-40	3-18
	8-48	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-35
	48-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	96-100	96-100	92-100	80-99	33-60	13-33
Va, Vb, Vc--------- Vanoss	0-12	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-95	22-37	2-14
	12-38	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-45	12-22
	38-60	Loam, silt loam, clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	96-100	65-98	22-43	2-20
Vd----------------- Verdigris	0-29	Silt loam--------	CL	A-4, A-6, A-7	0	100	100	96-100	65-98	30-45	8-20
	29-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	96-100	80-98	30-45	8-20
Wa----------------- Waurika	0-12	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	100	96-100	80-95	22-37	3-14
	12-37	Clay, silty clay	CL, CH	A-7	0	95-100	95-100	90-100	80-98	41-66	20-40
	37-60	Silty clay loam, clay loam, clay.	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-98	38-55	16-30

* NP means nonplastic.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Aa	0-9	2.0-6.0	0.10-0.13	5.6-7.3	<2	Low	0.24	5	2
Attica	9-20	2.0-6.0	0.12-0.17	5.6-6.5	<2	Low	0.24		
	20-60	2.0-6.0	0.08-0.16	6.1-7.8	<2	Low	0.24		
Ab*:									
Attica	0-9	2.0-6.0	0.10-0.13	5.6-7.3	<2	Low	0.24	5	2
	9-20	2.0-6.0	0.12-0.17	5.6-6.5	<2	Low	0.24		
	20-60	2.0-6.0	0.08-0.16	6.1-7.8	<2	Low	0.24		
Tivoli	0-7	6.0-20.0	0.05-0.11	6.1-7.8	<2	Low	0.17	5	1
	7-60	6.0-20.0	0.02-0.06	6.1-8.4	<2	Low	0.17		
Ba, Bb	0-9	0.06-2.0	0.18-0.22	5.6-7.3	<2	Low	0.43	5	6
Bethany	9-16	0.20-0.60	0.16-0.20	6.1-7.3	<2	Moderate	0.37		
	16-60	0.06-0.20	0.14-0.18	6.6-8.4	<2	High	0.37		
Bc	0-15	0.2-0.6	0.15-0.24	5.6-7.3	<2	Moderate	0.43	5	7
Brewer	15-42	0.06-0.2	0.12-0.22	6.1-8.4	<2	High	0.37		
	42-60	0.06-0.6	0.12-0.22	6.6-8.4	<8	Moderate	0.43		
Ca	0-28	2.0-6.0	0.11-0.20	5.6-8.4	<2	Low	0.20	5	3
Canadian	28-60	2.0-20	0.07-0.20	6.1-8.4	<2	Low	0.20		
Cb*:									
Clime	0-8	0.20-0.6	0.12-0.20	7.4-8.4	<2	Moderate	0.28	3	4
	8-20	0.20-0.6	0.12-0.18	7.9-8.4	<2	Moderate	0.28		
	20-36	0.20-0.6	0.11-0.15	7.9-8.4	<2	Moderate	0.28		
	36	---	---	---	---	-----------	---		
Rock outcrop.									
Cc*:									
Clime	0-8	0.20-0.6	0.12-0.20	7.4-8.4	<2	Moderate	0.28	3	4
	8-20	0.20-0.6	0.12-0.18	7.9-8.4	<2	Moderate	0.28		
	20-36	0.20-0.6	0.11-0.15	7.9-8.4	<2	Moderate	0.28		
	36	---	---	---	---	-----------	---		
Sogn	0-10	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.28	1	4L
	10	---	---	---	---	-----------	---		
Da	0-42	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	0.37	5	6
Dale	42-60	0.6-2.0	0.15-0.24	7.4-8.4	<2	Moderate	0.37		
Db	0-5	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low	0.43	3	6
Dwight	5-28	<0.06	0.10-0.15	6.1-8.4	<4	High	0.32		
	28-54	0.06-0.6	0.10-0.15	6.6-8.4	<8	High	0.32		
	54	---	---	---	---	-----------	---		
Fa	0-14	0.6-2.0	0.08-0.15	5.6-7.3	<2	Low	0.24	3	8
Florence	14-17	0.2-0.6	0.04-0.10	5.6-7.3	<2	Moderate	0.24		
	17-45	0.2-0.6	0.03-0.09	6.1-7.8	<2	Moderate	0.24		
	45	---	---	---	---	-----------	---		
Ia	0-13	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7
Irwin	13-40	<0.06	0.10-0.15	5.6-8.4	<2	High	0.37		
	40-60	<0.2	0.09-0.15	6.6-8.4	<2	High	0.37		
Ib	0-28	0.6-2.0	0.21-0.24	7.4-8.4	<2	Moderate	0.32	5	6
Ivan	28-60	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
La, Lb, Lc------- Labette	0-7	0.2-0.6	0.21-0.24	5.6-6.5	<2	Moderate	0.37	3	7
	7-36	0.06-0.2	0.18-0.23	5.6-8.4	<2	High------	0.37		
	36	---	---	---	---	----------	---		
Ld*:									
Labette---------	0-7	0.2-0.6	0.21-0.24	5.6-6.5	<2	Moderate	0.37	3	7
	7-36	0.06-0.2	0.18-0.23	5.6-8.4	<2	High------	0.37		
	36	---	---	---	---	----------	---		
Dwight----------	0-5	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.43	3	6
	5-28	<0.06	0.10-0.15	6.1-8.4	<4	High------	0.32		
	28-54	0.06-0.6	0.10-0.15	6.6-8.4	<8	High------	0.32		
	54	---	---	---	---	----------	---		
Le*:									
Labette---------	0-7	0.2-0.6	0.21-0.24	5.6-6.5	<2	Moderate	0.37	3	7
	7-36	0.06-0.2	0.18-0.23	5.6-8.4	<2	High------	0.37		
	36	---	---	---	---	----------	---		
Sogn------------	0-10	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.28	1	4L
	10	---	---	---	---	----------	---		
Lf--------------- Lesho	0-24	0.2-0.6	0.17-0.22	7.4-9.0	<2	Moderate	0.28	4	6
	24-60	>2.0	0.02-0.10	7.4-9.0	<2	Low--------	0.15		
Lg*:									
Lincoln---------	0-9	0.2-6.0	0.10-0.24	7.4-8.4	<2	Low--------	0.32	5	3
	9-60	6.0-20	0.05-0.10	7.9-8.4	<2	Low--------	0.17		
Tivoli----------	0-7	6.0-20.0	0.05-0.11	6.1-7.8	<2	Low--------	0.17	5	1
	7-60	6.0-20.0	0.02-0.06	6.1-8.4	<2	Low--------	0.17		
Ma, Mb, Mc------- Martin	0-15	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7
	15-60	0.06-0.2	0.12-0.18	5.6-7.8	<2	High------	0.37		
Md*:									
Martin----------	0-15	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7
	15-60	0.06-0.2	0.12-0.18	5.6-7.8	<2	High------	0.37		
Florence--------	0-14	0.6-2.0	0.08-0.15	5.6-7.3	<2	Low--------	0.24	3	8
	14-17	0.2-0.6	0.04-0.10	5.6-7.3	<2	Moderate	0.24		
	17-45	0.2-0.6	0.03-0.09	6.1-7.8	<2	Moderate	0.24		
	45	---	---	---	---	----------	---		
Me--------------- Milan	0-9	0.6-2.0	0.13-0.21	5.6-6.5	<2	Low--------	0.28	5	3
	9-60	0.2-0.6	0.14-0.21	5.6-7.3	<2	Moderate	0.28		
Mf, Mg----------- Minco	0-42	0.6-2.0	0.13-0.24	5.6-7.3	<2	Low--------	0.37	5	6
	42-60	0.6-2.0	0.11-0.24	6.1-8.4	<2	Low--------	0.37		
Na, Nb, Nc------- Norge	0-8	0.6-2.0	0.15-0.24	5.6-7.3	<2	Low--------	0.37	5	6
	8-60	0.2-0.6	0.15-0.22	5.6-8.4	<2	Moderate	0.32		
Oa--------------- Olpe	0-10	0.6-2.0	0.06-0.13	5.1-6.5	<2	Low--------	0.24	3	8
	10-22	0.2-0.6	0.04-0.10	5.1-6.5	<2	Low--------	0.24		
	22-60	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24		
Ob--------------- Osage	0-18	<0.06	0.12-0.14	5.1-7.3	<2	Very high	0.28	5	4
	18-60	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28		
Ra--------------- Reading	0-14	0.6-2.0	0.21-0.23	5.6-7.3	<2	Low--------	0.32	5	6
	14-50	0.2-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43		
	50-60	0.2-2.0	0.13-0.20	6.1-8.4	<2	Moderate	0.43		
Rb, Rc----------- Rosehill	0-8	<0.06	0.11-0.14	6.1-7.3	<2	High------	0.28	3	4
	8-37	<0.06	0.10-0.14	6.6-8.4	<2	High------	0.28		
	37-46	---	---	---	---	----------	---		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Sa, Sb, Sc--------- Smolan	0-15	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low--------	0.37	5	7
	15-40	0.06-0.2	0.12-0.18	5.6-7.8	<2	High-------	0.37		
	40-60	0.2-0.6	0.14-0.20	6.6-7.8	<2	Moderate	0.37		
Sd----------------- Sogn	0-10	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.28	1	4L
	10	---	---	---	---	-----------	---		
Ta, Tb------------- Tabler	0-8	0.2-0.6	0.15-0.24	5.6-8.4	<2	Low--------	0.49	5	6
	8-48	<0.06	0.12-0.18	6.1-8.4	<2	High-------	0.37		
	48-60	<0.06	0.12-0.22	7.4-8.4	<2	High-------	0.43		
Va, Vb, Vc--------- Vanoss	0-12	0.6-2.0	0.15-0.20	5.1-6.5	<2	Low--------	0.37	5	6
	12-38	0.6-2.0	0.17-0.22	5.1-6.5	<2	Moderate	0.37		
	38-60	0.6-2.0	0.16-0.21	5.6-6.5	<2	Low--------	0.37		
Vd----------------- Verdigris	0-29	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6
	29-60	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32		
Wa----------------- Waurika	0-12	0.6-2.0	0.16-0.20	5.6-7.3	<2	Low--------	0.49	5	6
	12-37	<0.06	0.13-0.17	6.6-8.4	<2	High-------	0.37		
	37-60	0.06-0.2	0.15-0.19	7.4-8.4	<2	Moderate	0.37		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
Aa: Attica	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Ab*:											
Attica	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Tivoli	A	None	---	---	>6.0	---	---	>60	---	Low	Low.
Ba, Bb: Bethany	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Bc: Brewer	C	Rare	---	---	>6.0	---	---	>60	---	High	Moderate.
Ca: Canadian	B	Rare	---	---	>6.0	---	---	>60	---	Low	Low.
Cb*:											
Clime	C	None	---	---	>6.0	---	---	20-40	Rippable	High	Low.
Rock outcrop.											
Cc*:											
Clime	C	None	---	---	>6.0	---	---	20-40	Rippable	High	Low.
Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Low.
Da: Dale	B	Rare	---	---	>6.0	---	---	>60	---	Moderate	Low.
Db: Dwight	D	None	---	---	>6.0	---	---	>40	Hard	High	Moderate.
Fa: Florence	C	None	---	---	>6.0	---	---	40-60	Hard	Moderate	Low.
Ia: Irwin	D	None	---	---	>6.0	---	---	>40	Hard	High	Low.
Ib: Ivan	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
La, Lb, Lc: Labette	C	None	---	---	>6.0	---	---	20-40	Hard	High	Low.
Ld*:											
Labette	C	None	---	---	>6.0	---	---	20-40	Hard	High	Low.
Dwight	D	None	---	---	>6.0	---	---	>40	Hard	High	Moderate.
Le*:											
Labette	C	None	---	---	>6.0	---	---	20-40	Hard	High	Low.
Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Low.
Lf: Lesho	C	Occasional	Very brief	Mar-Jul	2.0-6.0	Apparent	Jan-Dec	>60	---	High	Low.
Lg*:											
Lincoln	A	Occasional	Very brief to brief.	Apr-Oct	5.0-8.0	Apparent	Nov-May	>60	---	Low	Low.
Tivoli	A	None	---	---	>6.0	---	---	>60	---	Low	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Ma, Mb, Mc: Martin	C	None	---	---	>6.0	---	---	>40	Rip-pable	High	Low.
Md*: Martin	C	None	---	---	>6.0	---	---	>40	Rip-pable	High	Low.
Florence	C	None	---	---	>6.0	---	---	40-60	Hard	Moderate	Low.
Me: Milan	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low.
Mf, Mg: Minco	B	None	---	---	>6.0	---	---	>60	---	Low	Low.
Na, Nb, Nc: Norge	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low.
Oa: Olpe	C	None	---	---	>6.0	---	---	>60	---	High	Moderate.
Ob: Osage	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	High	Moderate.
Ra: Reading	C	Rare	---	---	>6.0	---	---	>60	---	Moderate	Low.
Rb, Rc: Rosehill	D	None	---	---	>6.0	---	---	20-40	Rip-pable	High	Low.
Sa, Sb, Sc: Smolan	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Sd: Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Low.
Ta, Tb: Tabler	D	None	---	---	>6.0	---	---	>60	---	High	Low.
Va, Vb, Vc: Vanoss	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
Vd: Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
Wa: Waurika	D	None	---	---	1.0-2.0	Perched	Mar-May	>60	---	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Attica	Coarse-loamy, mixed, thermic Udic Haplustalfs
Bethany	Fine, mixed, thermic Pachic Paleustolls
Brewer	Fine, mixed, thermic Pachic Argiustolls
Canadian	Coarse-loamy, mixed, thermic Udic Haplustolls
Clime	Fine, mixed, mesic Udic Haplustolls
Dale	Fine-silty, mixed, thermic Pachic Haplustolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Florence	Clayey-skeletal, montmorillonitic, mesic Udic Argiustolls
Irwin	Fine, mixed, mesic Pachic Argiustolls
*Ivan	Fine-silty, mixed, mesic Cumulic Hapludolls
Labette	Fine, mixed, mesic Udic Argiustolls
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic Fluvaquentic Haplustolls
Lincoln	Sandy, mixed, thermic Typic Ustifluvents
*Martin	Fine, montmorillonitic, mesic Aquic Argiudolls
Milan	Fine-loamy, mixed, thermic Udic Argiustolls
Minco	Coarse-silty, mixed, thermic Udic Haplustolls
Norge	Fine-silty, mixed, thermic Udic Paleustolls
*Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
*Reading	Fine-silty, mixed, mesic Typic Argiudolls
Rosehill	Fine, montmorillonitic, mesic Udertic Haplustolls
Smolan	Fine, montmorillonitic, mesic Pachic Argiustolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Tabler	Fine, montmorillonitic, thermic Vertic Argiustolls
Tivoli	Mixed, thermic Typic Ustipsamments
Vanoss	Fine-silty, mixed, thermic Udic Argiustolls
*Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Waurika	Fine, montmorillonitic, thermic Typic Argialbolls

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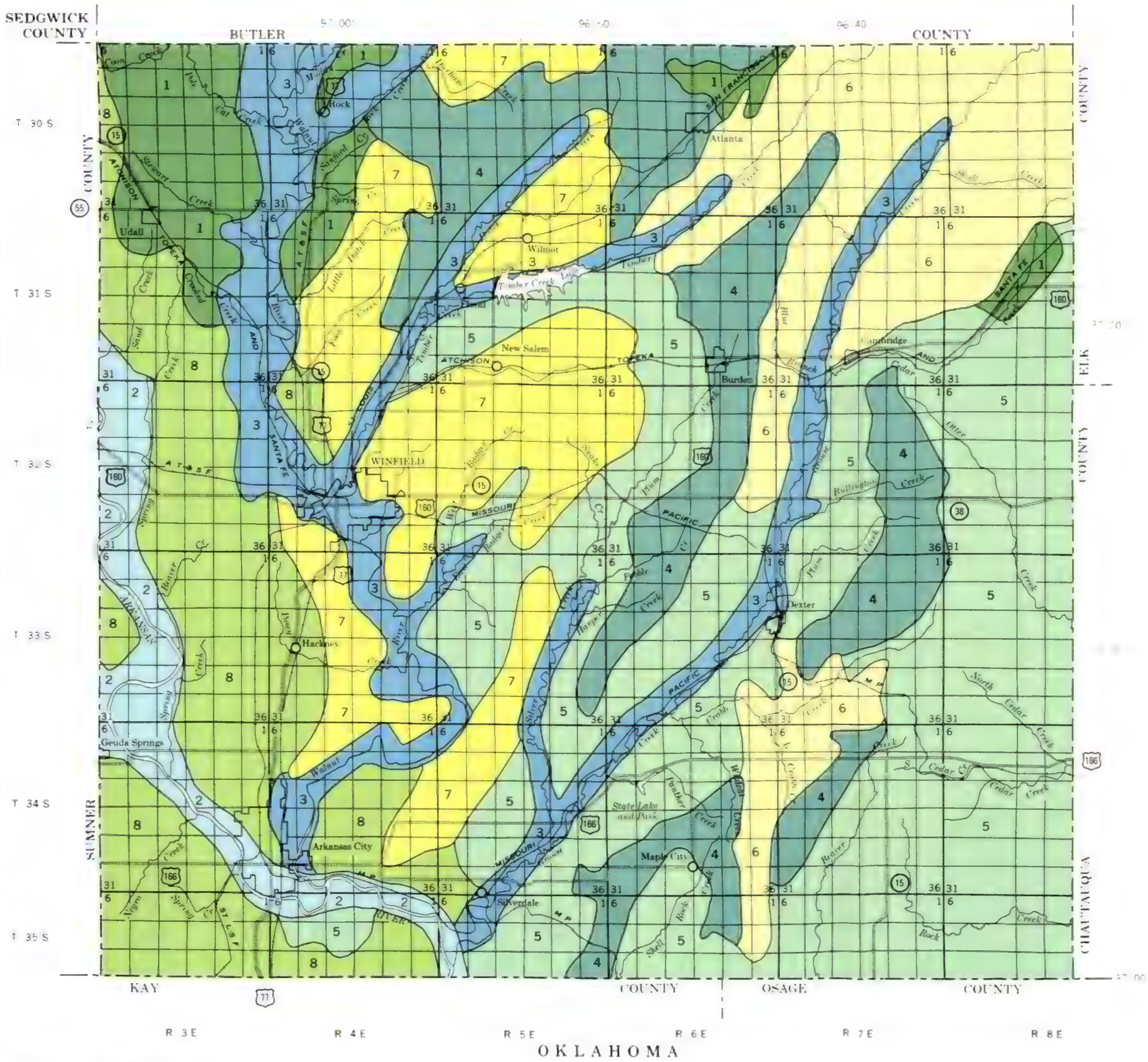
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
COWLEY COUNTY, KANSAS



N

SOIL LEGEND

1 Irwin–Tabler–Rosehill: Deep and moderately deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a clayey subsoil; on uplands

2 Dale–Canadian–Lincoln: Deep, nearly level, well drained and somewhat excessively drained soils that have a silty or loamy subsoil or a sandy upper substratum; on stream terraces and flood plains

3 Verdigris–Brewer–Norge: Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a silty or clayey subsoil; on stream terraces, flood plains, and adjacent uplands

4 Labette–Dwight–Irwin: Moderately deep and deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a clayey or silty subsoil; on uplands

5 Clime–Sogn–Martin: Shallow to deep, gently sloping to steep, moderately well drained and somewhat excessively drained soils that have a clayey or silty subsoil or lack a subsoil; on uplands

6 Florence–Martin–Labette: Deep and moderately deep, gently sloping to strongly sloping, well drained and moderately well drained soils that have a cherty clay subsoil or clayey and silty subsoil; on uplands

7 Labette–Smolan–Sogn: Deep to shallow, gently sloping to moderately sloping, well drained and somewhat excessively drained soils that have a clayey and silty subsoil or lack a subsoil; on uplands

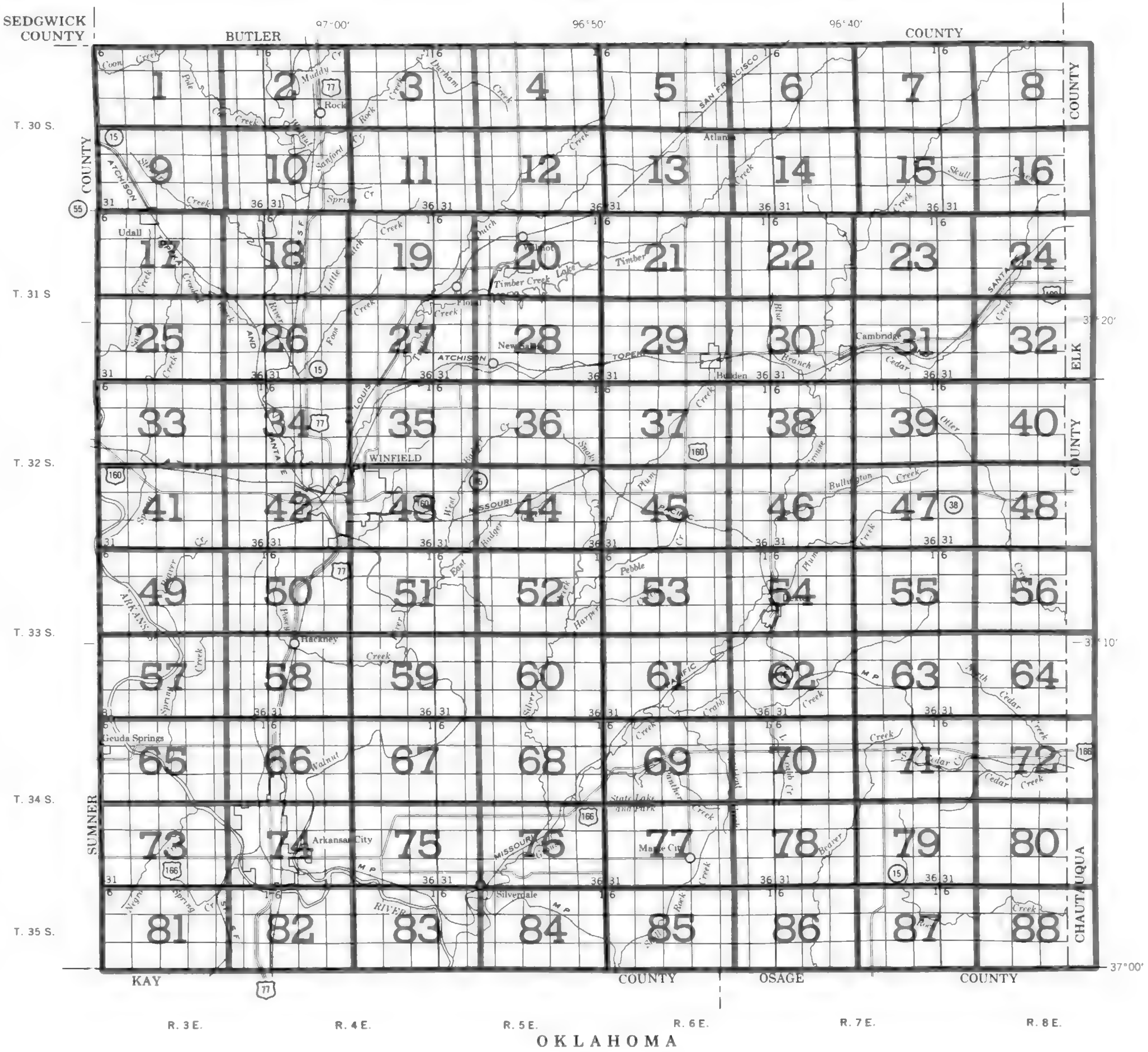
8 Vanoss–Bethany–Tabler: Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a silty or clayey subsoil; on uplands

Compiled 1979

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

COWLEY COUNTY, KANSAS

Scale 1: 253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Aa	Attica loamy fine sand, 3 to 6 percent slopes
Ab	Attica–Tivoli loamy fine sands, 3 to 15 percent slopes
Ba	Bethany silt loam, 0 to 1 percent slopes
Bb	Bethany silt loam, 1 to 3 percent slopes
Bc	Brewer silty clay loam
Ca	Canadian fine sandy loam
Cb	Clime–Rock outcrop complex, 15 to 35 percent slopes
Cc	Clime–Sogn complex, 2 to 15 percent slopes
Da	Dale silt loam
Db	Dwight silt loam
Fa	Florence cherty silt loam, 5 to 15 percent slopes
Ia	Irwin silty clay loam, 1 to 3 percent slopes
Ib	Ivan silt loam
La	Labette silty clay loam, 1 to 3 percent slopes
Lb	Labette silty clay loam, 3 to 7 percent slopes
Lc	Labette silty clay loam, 2 to 7 percent slopes, eroded
Ld	Labette–Dwight complex, 1 to 3 percent slopes
Le	Labette–Sogn silty clay loams, 2 to 8 percent slopes
Lf	Lesho clay loam
Lg	Lincoln–Tivoli complex, 0 to 10 percent slopes
Ma	Martin silty clay loam, 1 to 3 percent slopes
Mb	Martin silty clay loam, 3 to 7 percent slopes
Mc	Martin silty clay loam, 2 to 7 percent slopes, eroded
Md	Martin–Florence complex, 2 to 12 percent slopes
Me	Milan fine sandy loam, 1 to 5 percent slopes
Mf	Minco silt loam, 3 to 7 percent slopes
Mg	Minco silt loam, 7 to 15 percent slopes
Na	Norge silt loam, 1 to 3 percent slopes
Nb	Norge silt loam, 3 to 7 percent slopes
Nc	Norge silty clay loam, 3 to 7 percent slopes, eroded
Oa	Olpe gravelly silt loam, 2 to 12 percent slopes
Ob	Osage silty clay
Ra	Reading silt loam
Rb	Rosehill silty clay, 1 to 3 percent slopes
Rc	Rosehill silty clay, 3 to 6 percent slopes
Sa	Smolan silty clay loam, 1 to 3 percent slopes
Sb	Smolan silty clay loam, 3 to 7 percent slopes
Sc	Smolan silty clay loam, 3 to 7 percent slopes, eroded
Sd	Sogn silty clay loam, 0 to 10 percent slopes
Ta	Tabler silty clay loam, 0 to 1 percent slopes
Tb	Tabler silty clay loam, 1 to 3 percent slopes
Va	Vanoss silt loam, 0 to 1 percent slopes
Vb	Vanoss silt loam, 1 to 3 percent slopes
Vc	Vanoss silt loam, 3 to 7 percent slopes
Vd	Verdigris silt loam
Wa	Waurika silt loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

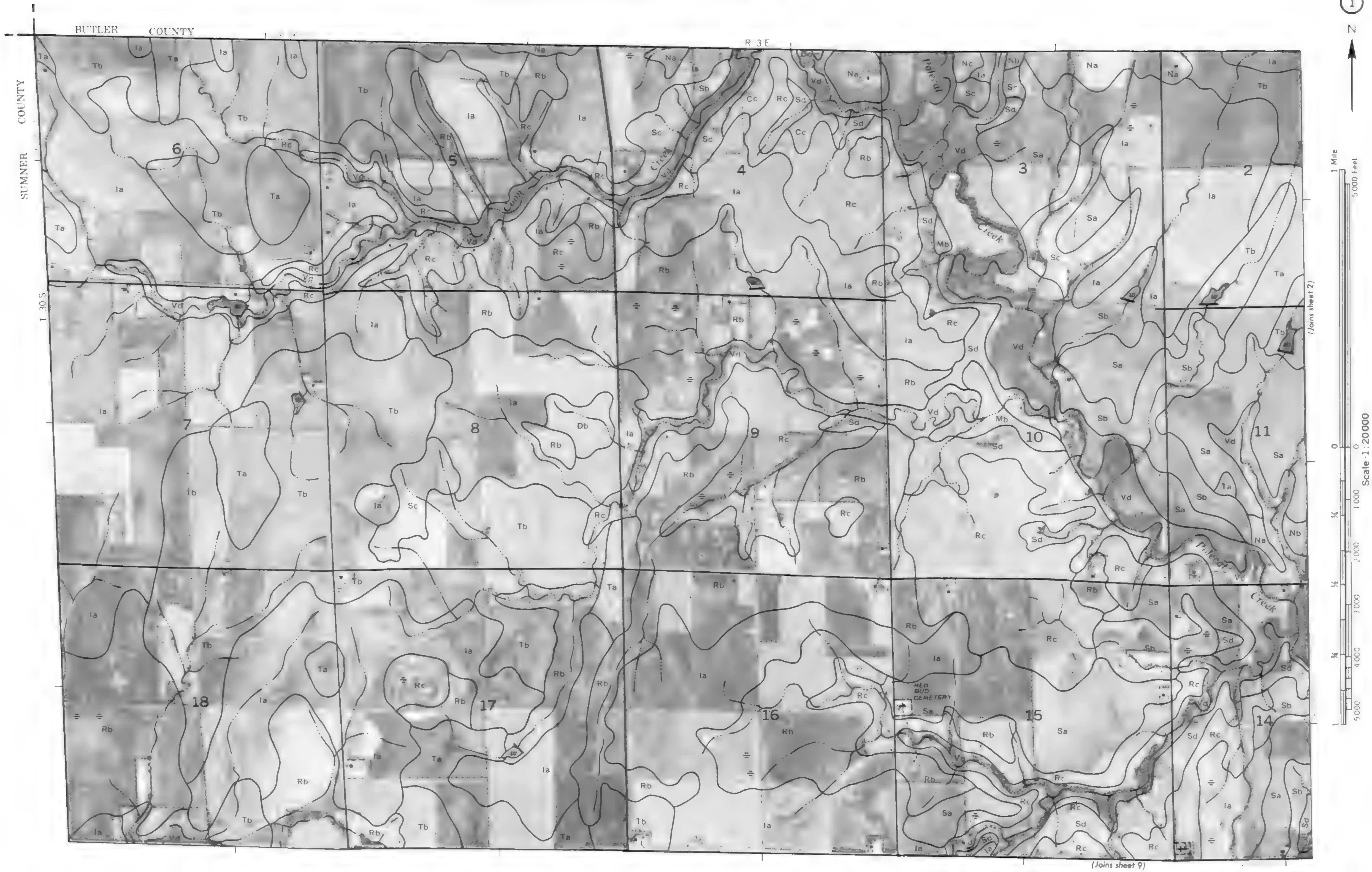
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Oil wasteland spot



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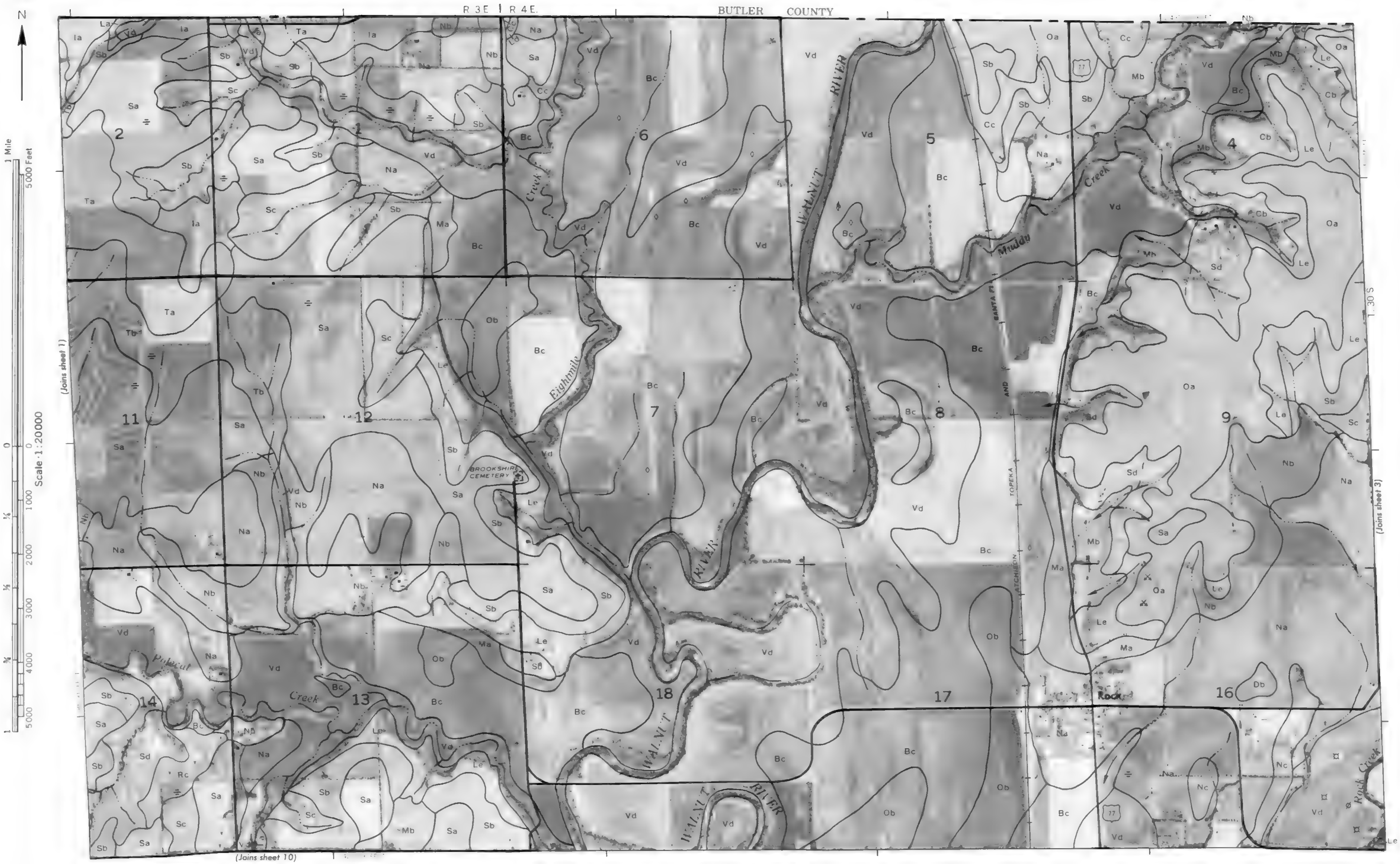
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

COWLEY COUNTY, KANSAS — SHEET NUMBER 2



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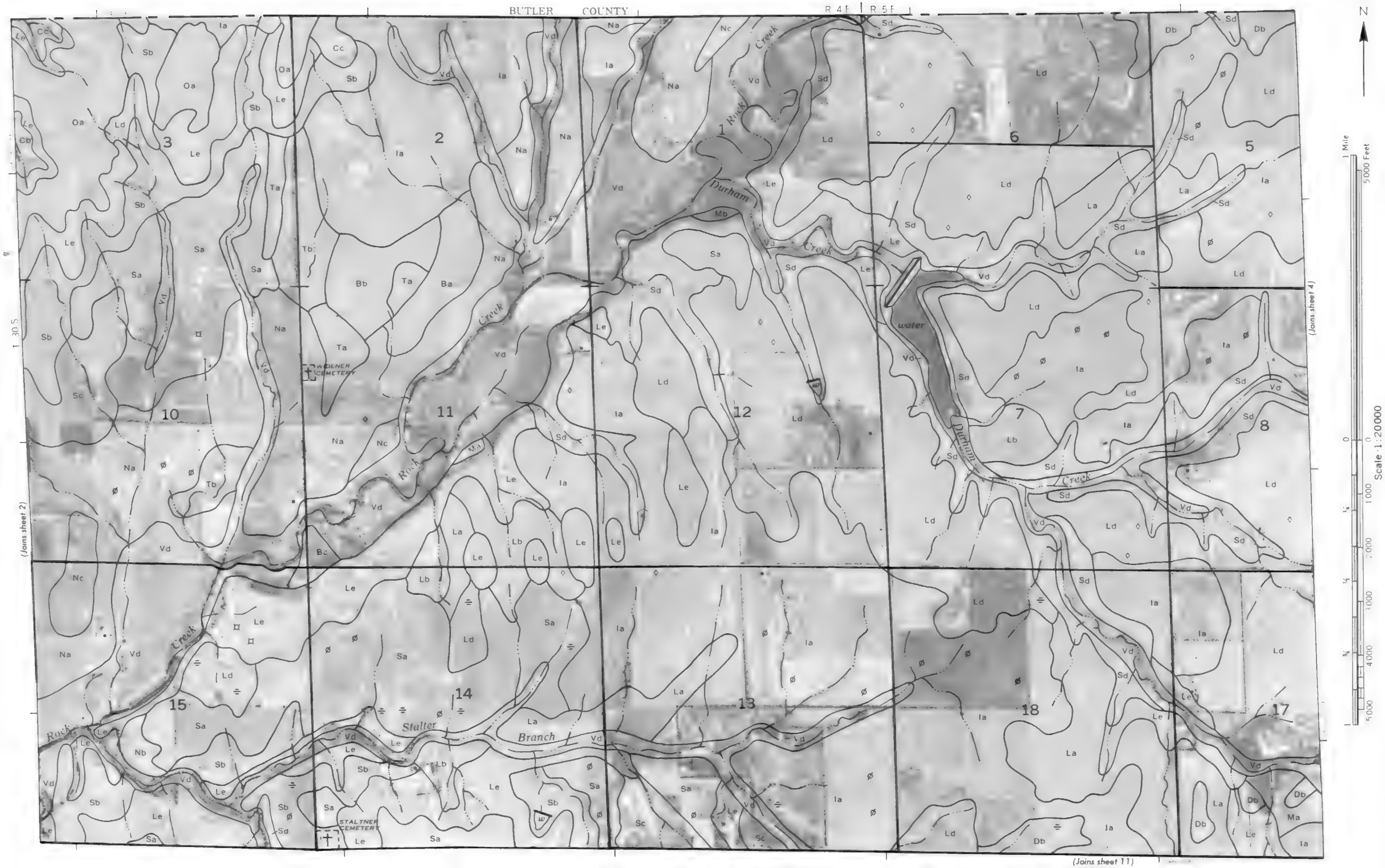
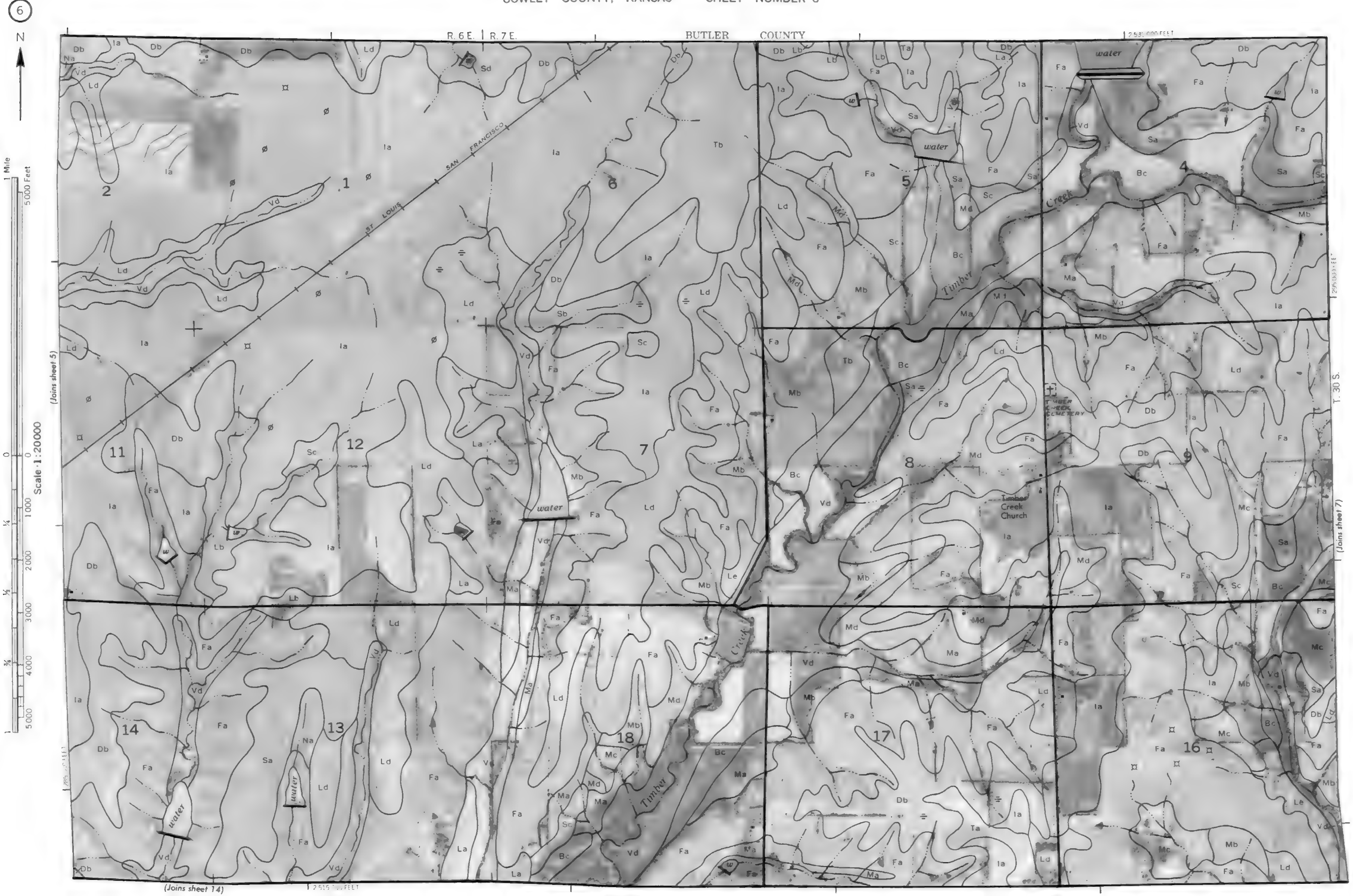

BUTLER COUNTY
R 4 E
R 5 E
N
T 30 S
Rock Creek
Durham Creek
Stalter Branch
water
WIDLNER CEMETERY
STALTNER CEMETERY
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 11)
1 Mile
5000 Feet
Scale 1:20000

COWLEY COUNTY, KANSAS — SHEET NUMBER 4

5


BUTLER COUNTY R. 6 E
T 30 S
Upper Dutch Creek
Dutch Creek
Lower Dutch Creek
water
Atlanta
ATLANTA CEMETERY
ST LOUIS SAN FRANCISCO
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 13)
N
1 Mile
5000 Feet
Scale 1:20000



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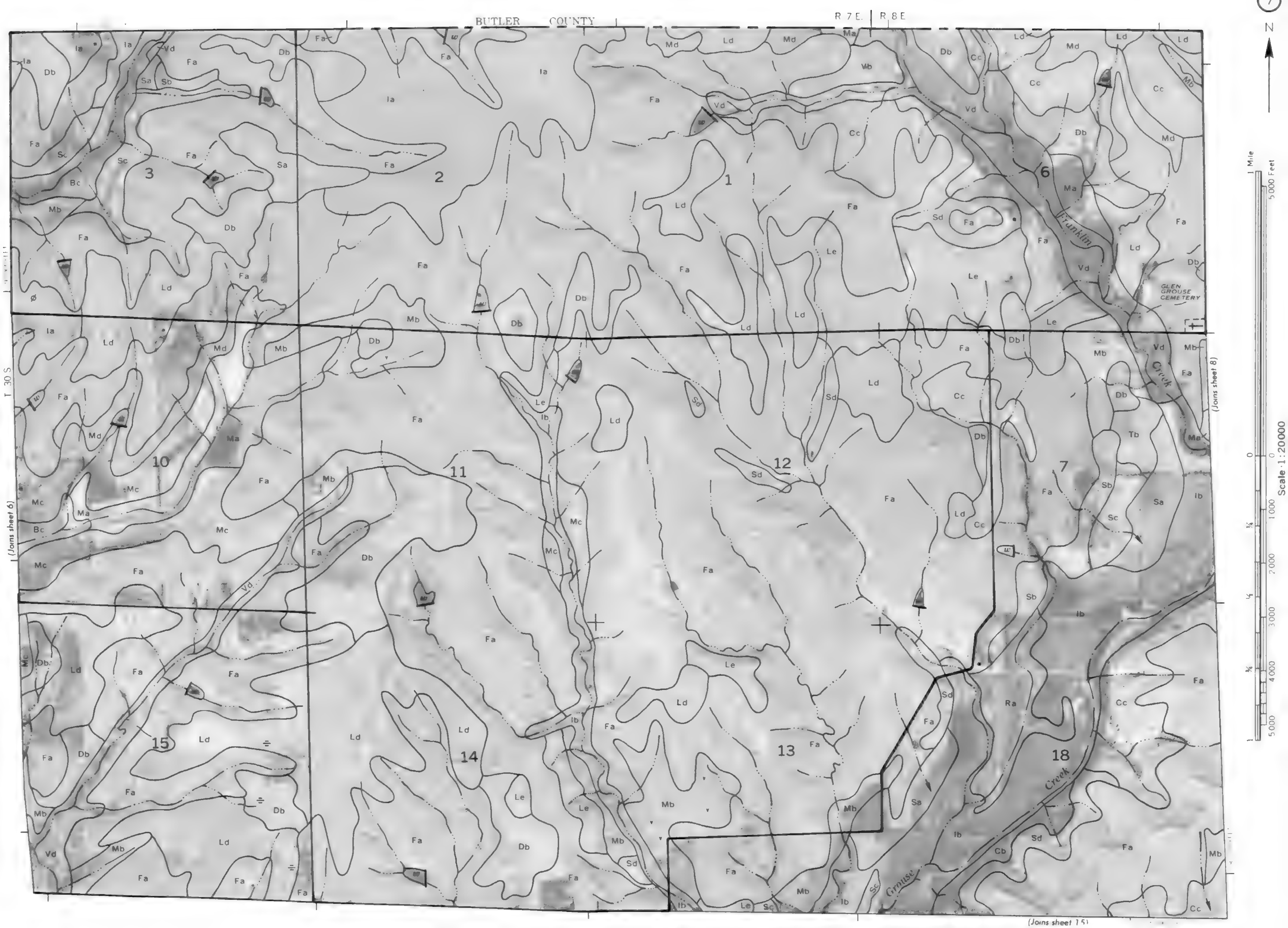
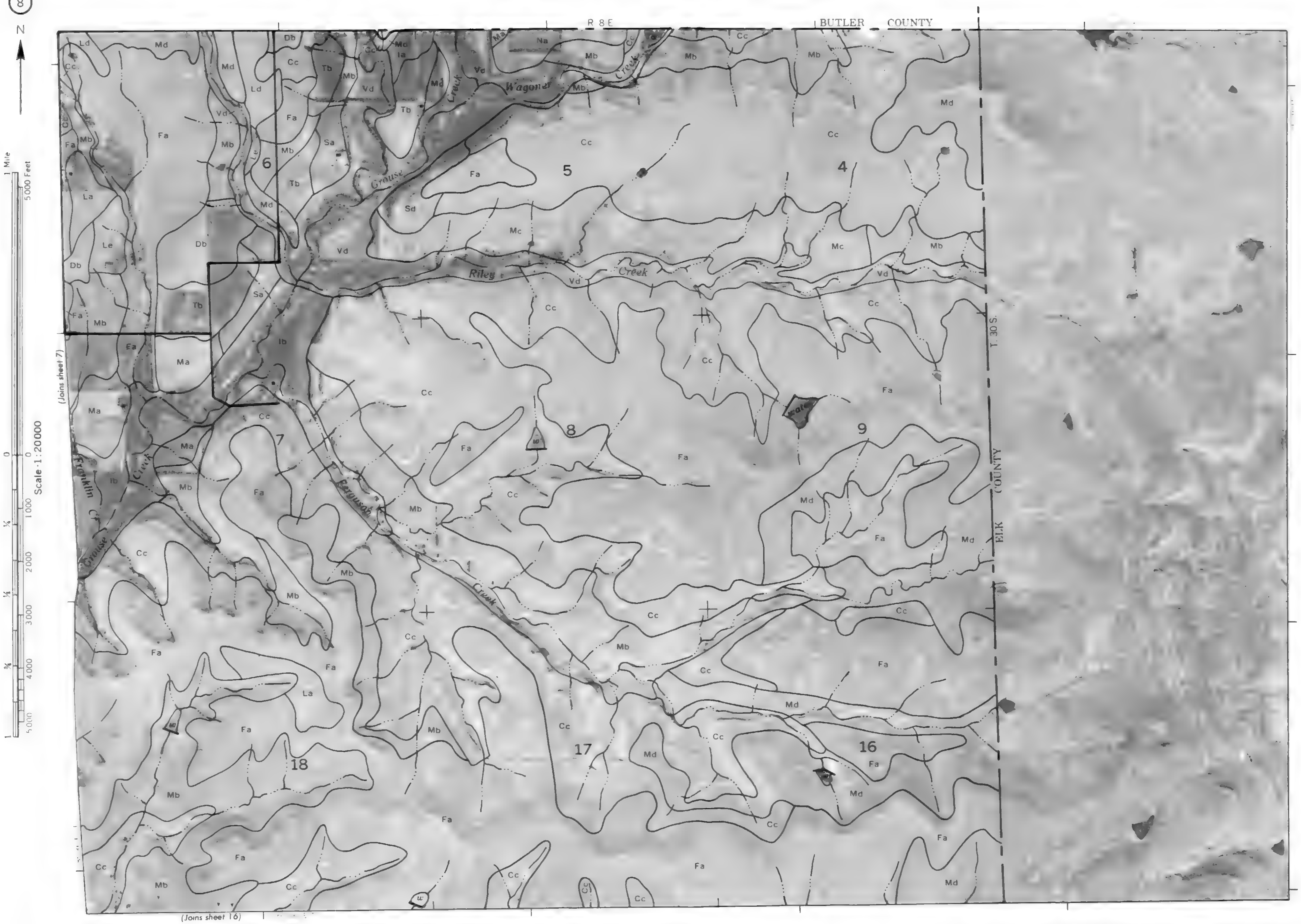
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


BUTLER COUNTY
R 7 E. | R 8 E
T 30 S
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 15)
Franklin Creek
Grouse Creek
GLEN GROUSE CEMETERY
N
1 Mile
5000 Feet
Scale 1:20000


8
N
1 Mile
5000 Feet
Scale 1:20000
R 8 E
BUTLER COUNTY
ELK COUNTY
T. 30 S.
(Joins sheet 7)
(Joins sheet 16)
Wagoner Creek
Grouse Creek
Riley Creek
Ferguson Creek
Franklin Cr.
Water
4
5
6
7
8
9
16
17
18
Cc
Fa
Mb
Mc
Md
Ma
Vd
Tb
Sa
Sd
Ld
Le
La
Db
Ib
Na

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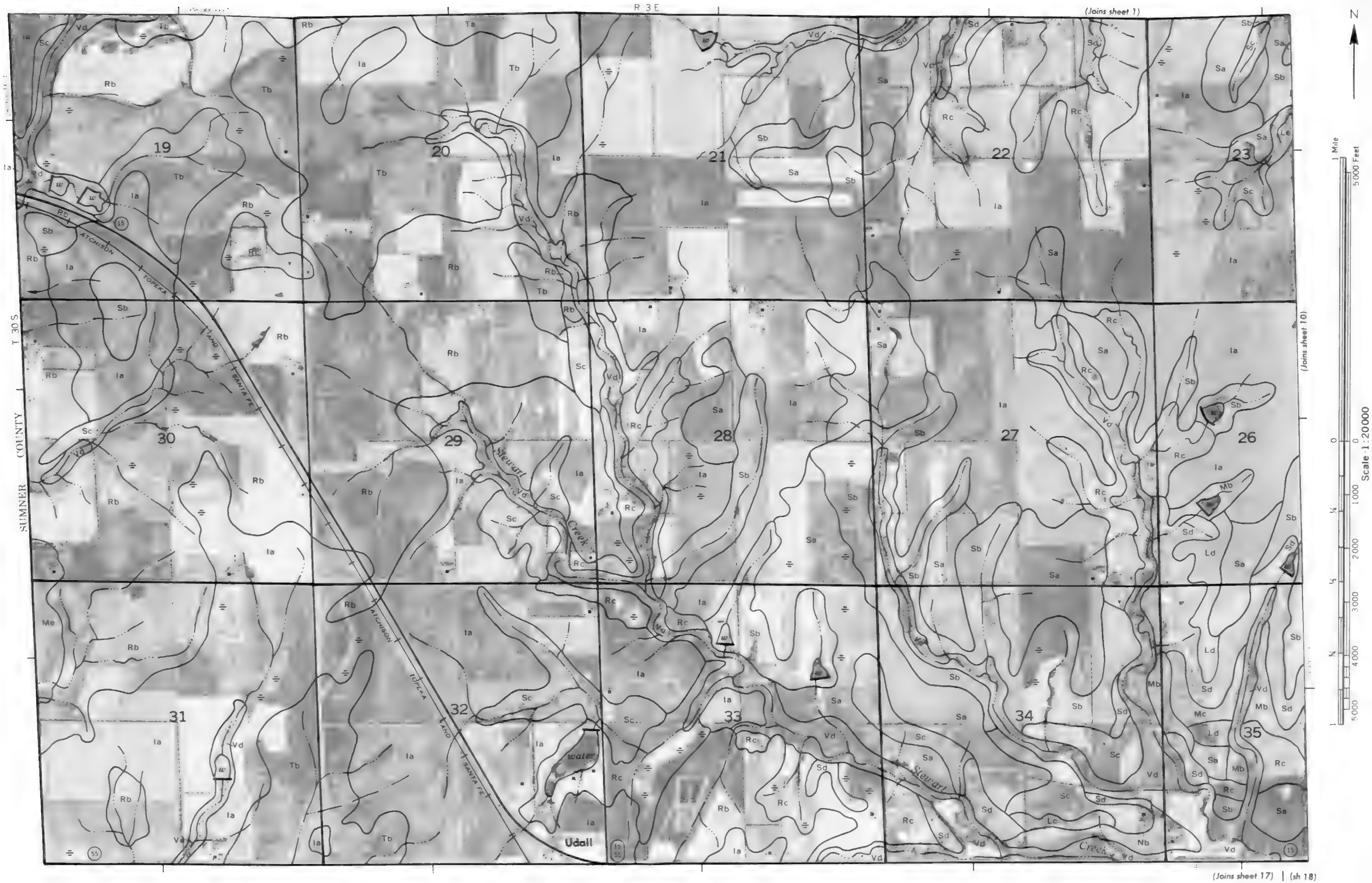
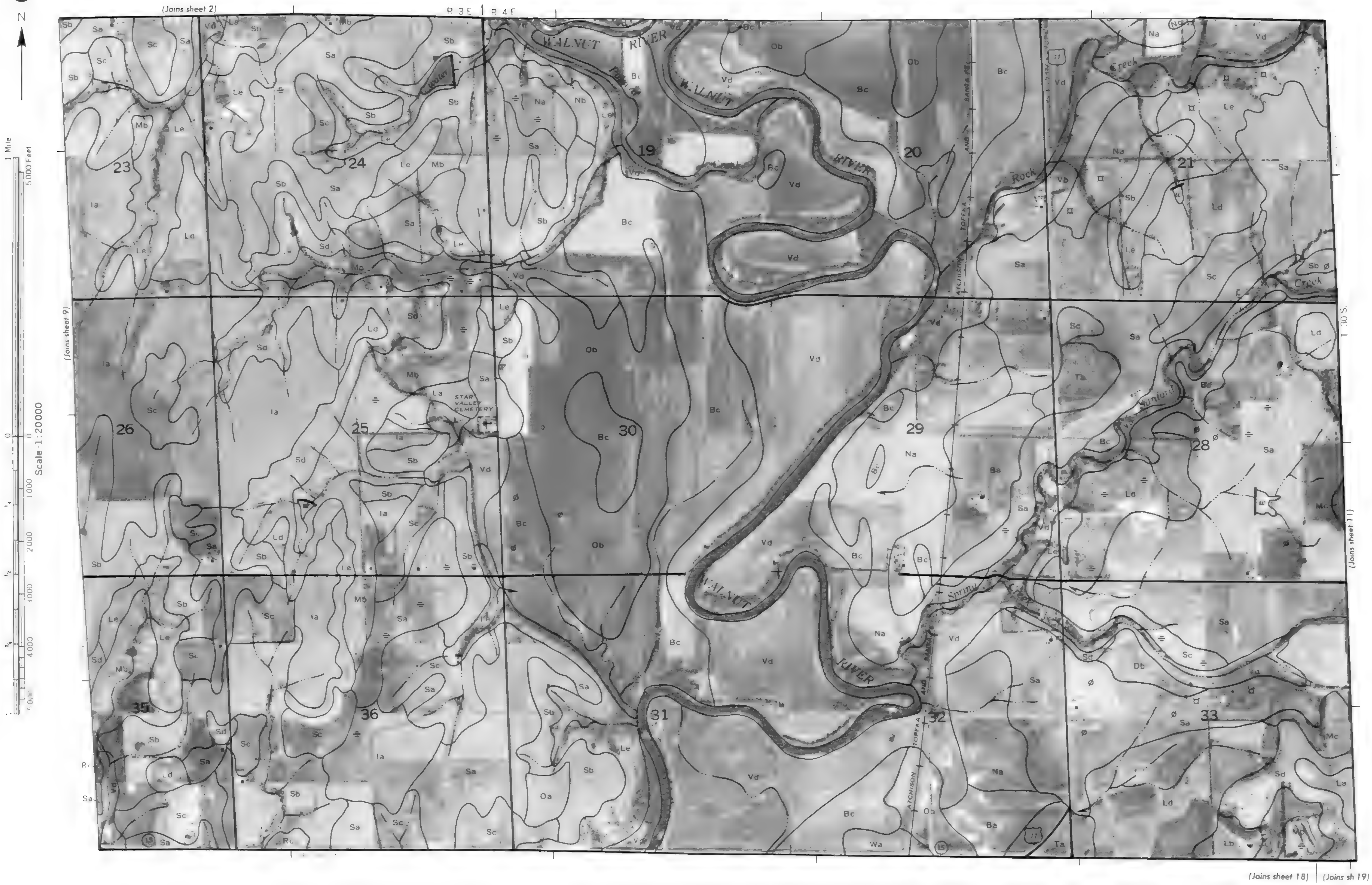
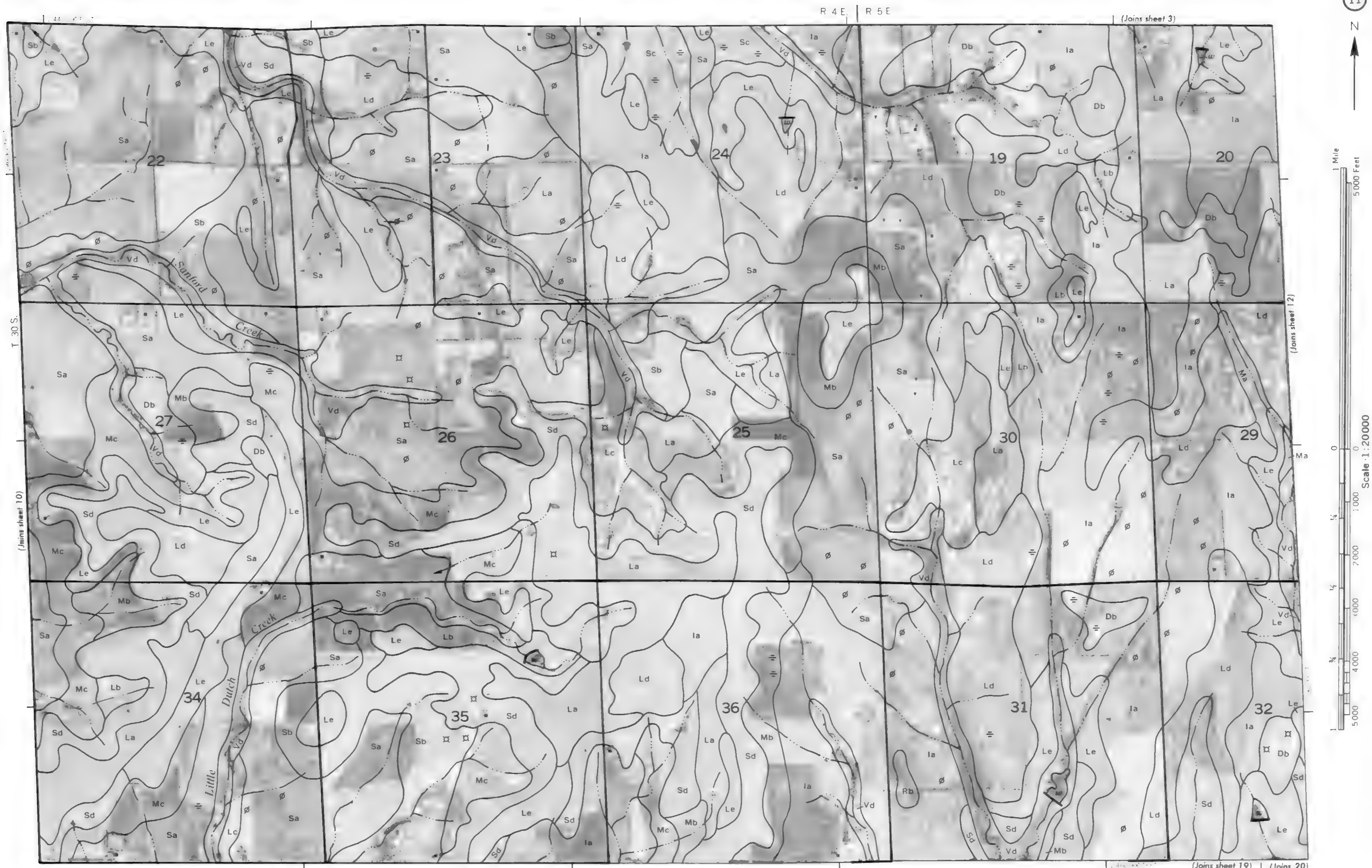
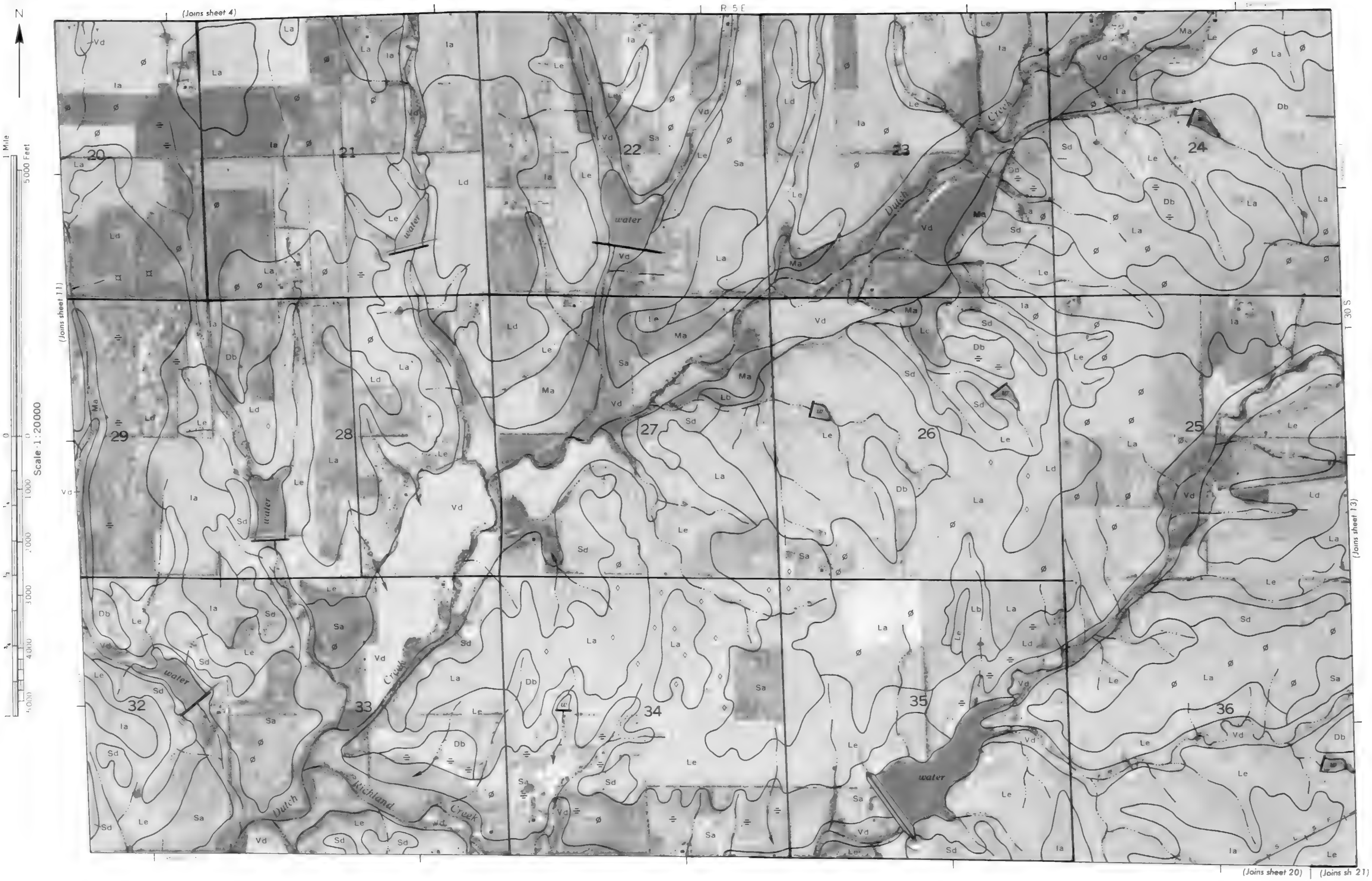
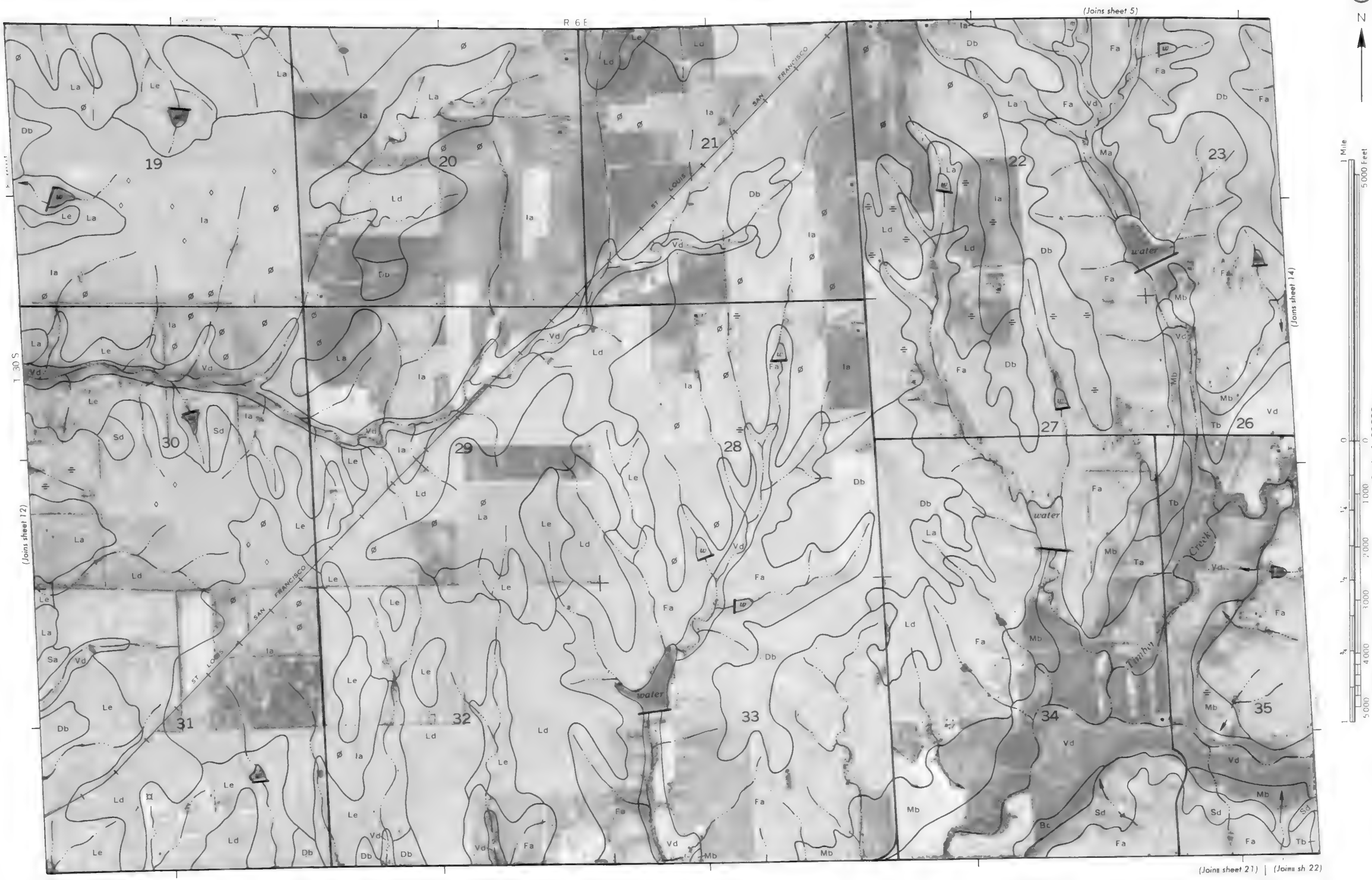


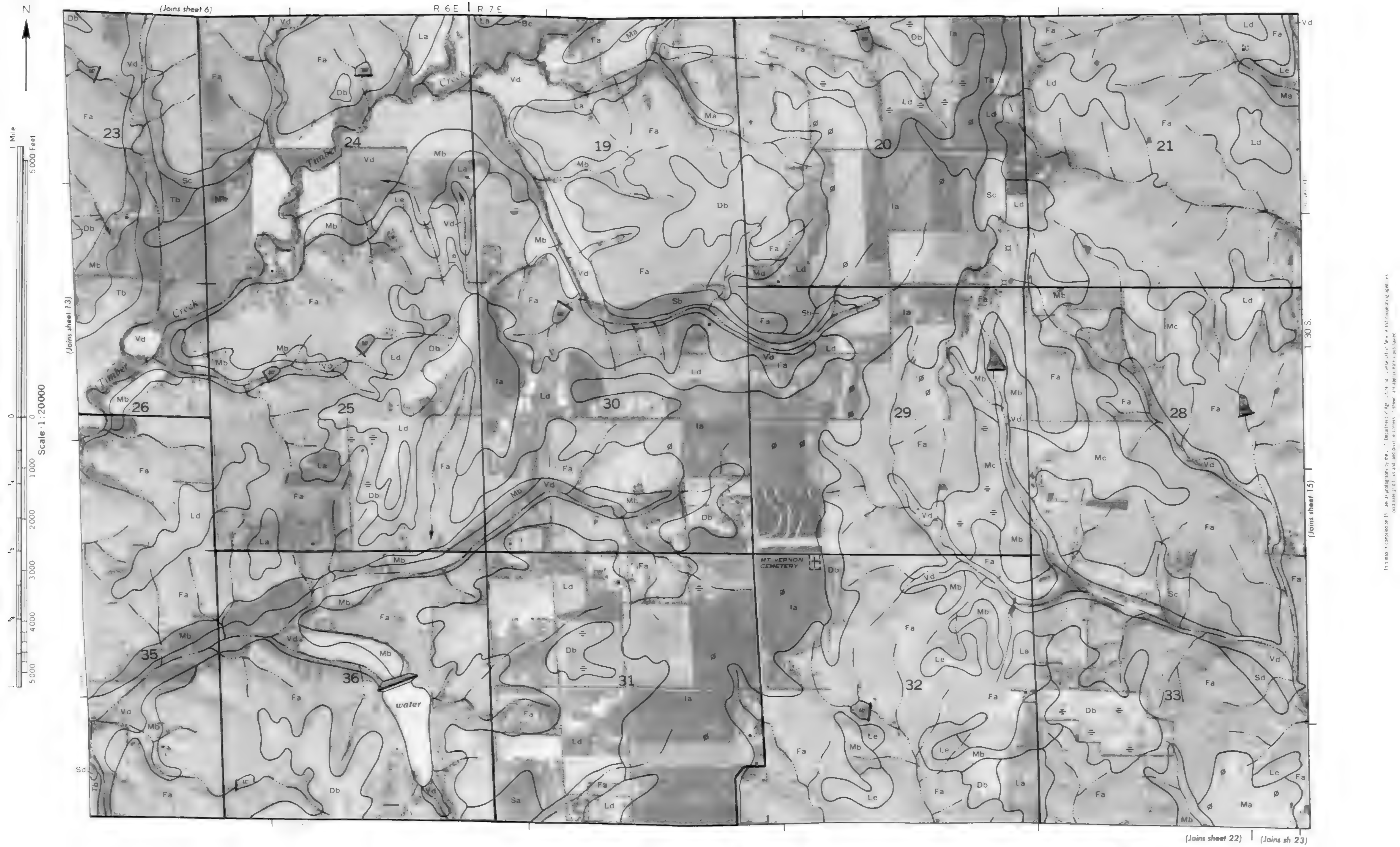

N
(Joins sheet 2)
R 3 E
R 4 E
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 18)
(Joins sh 19)
30 S.
1 Mile
5000 Feet
Scale 1:20000
WALNUT RIVER
WALNUT
RIVER
WALNUT
RIVER
Rock Creek
Creek
Spring Creek
STAR VALLEY CEMETERY
ATCHISON TOPEKA AND SANTA FE
Water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


11
R 4 E.
R 5 E
(Joins sheet 3)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 19)
(Joins 20)
T 30 S.
N
1 Mile
5000 Feet
Scale 1:20000
Sanford Creek
Little Dutch Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32

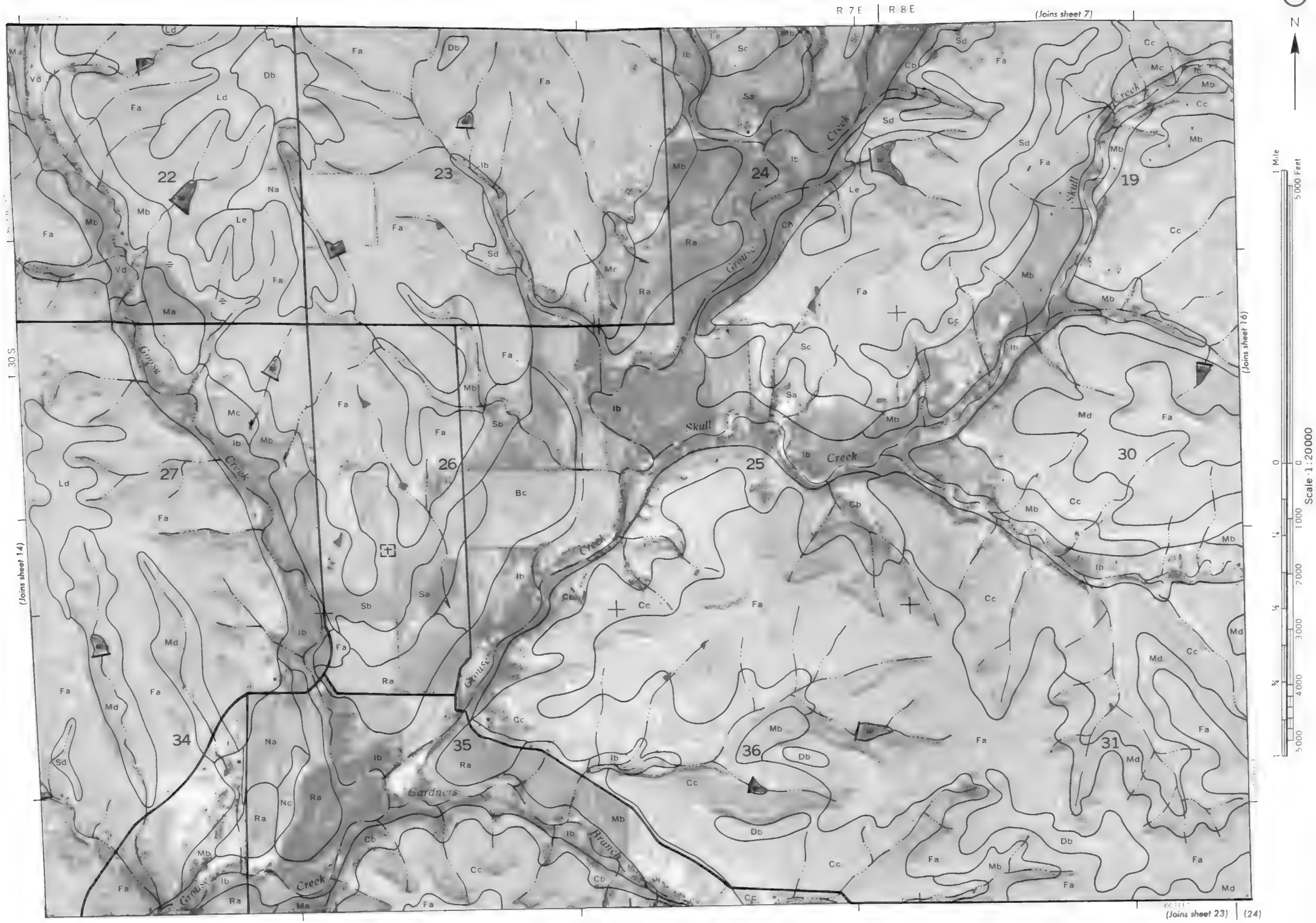

N
(Joins sheet 4)
R 5 E
T 30 S
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 20)
(Joins sh 21)
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
water
Dutch Creek
Richland Creek


13
N
(Joins sheet 5)
R 6 E
T 30 S
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 21)
(Joins sh 22)
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
ST LOUIS SAN FRANCISCO
water
Timber Creek
1 Mile
5000 Feet
Scale 1:20000

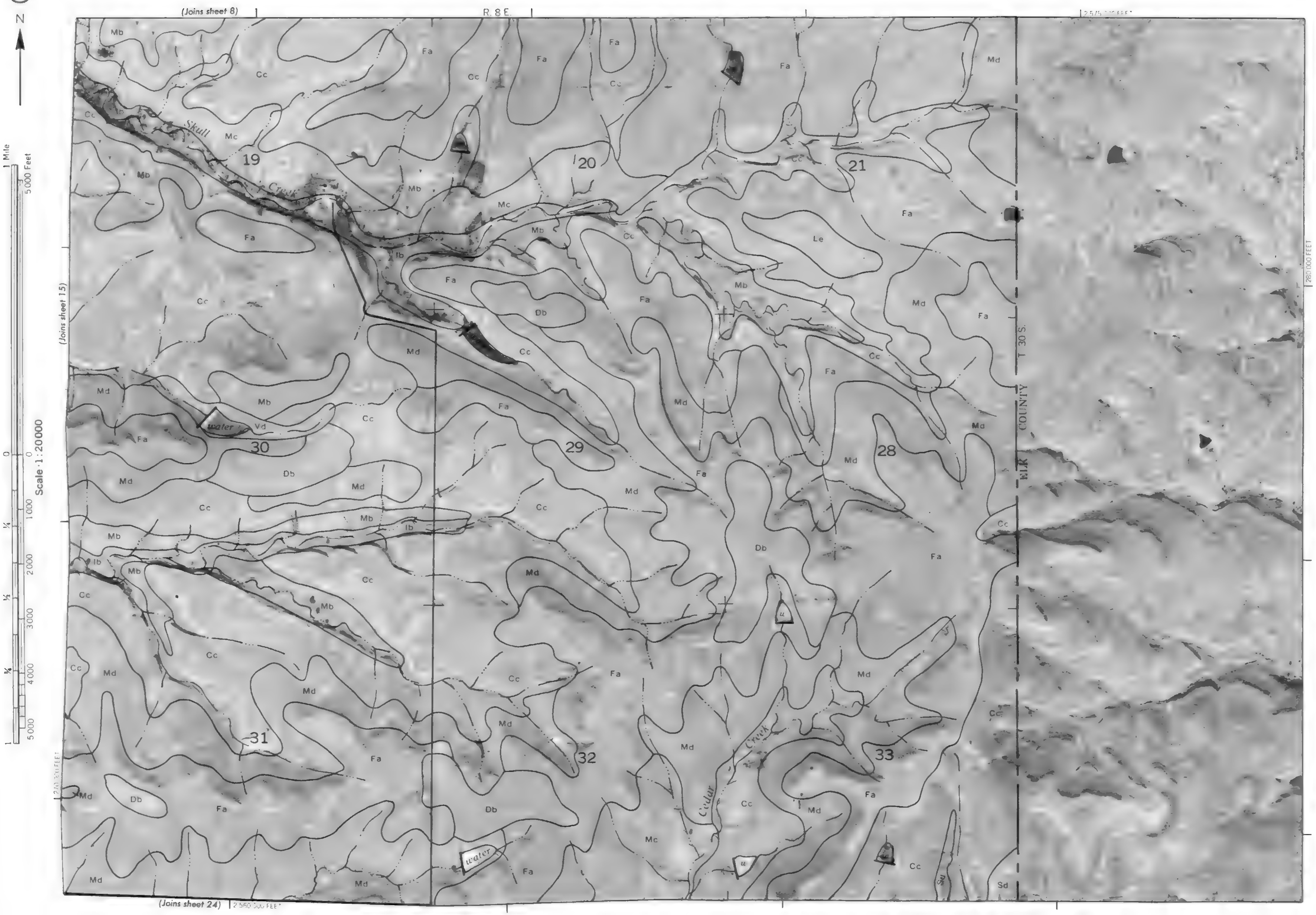
COWLEY COUNTY, KANSAS — SHEET NUMBER 14



15


R 7 E
R 8 E
(Joins sheet 7)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 23)
(24)
T 30 S
N
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1000
2000
3000
4000
5000
22
23
24
19
27
26
25
30
34
35
36
31
Grouse Creek
Skull Creek
Gardners Branch

16



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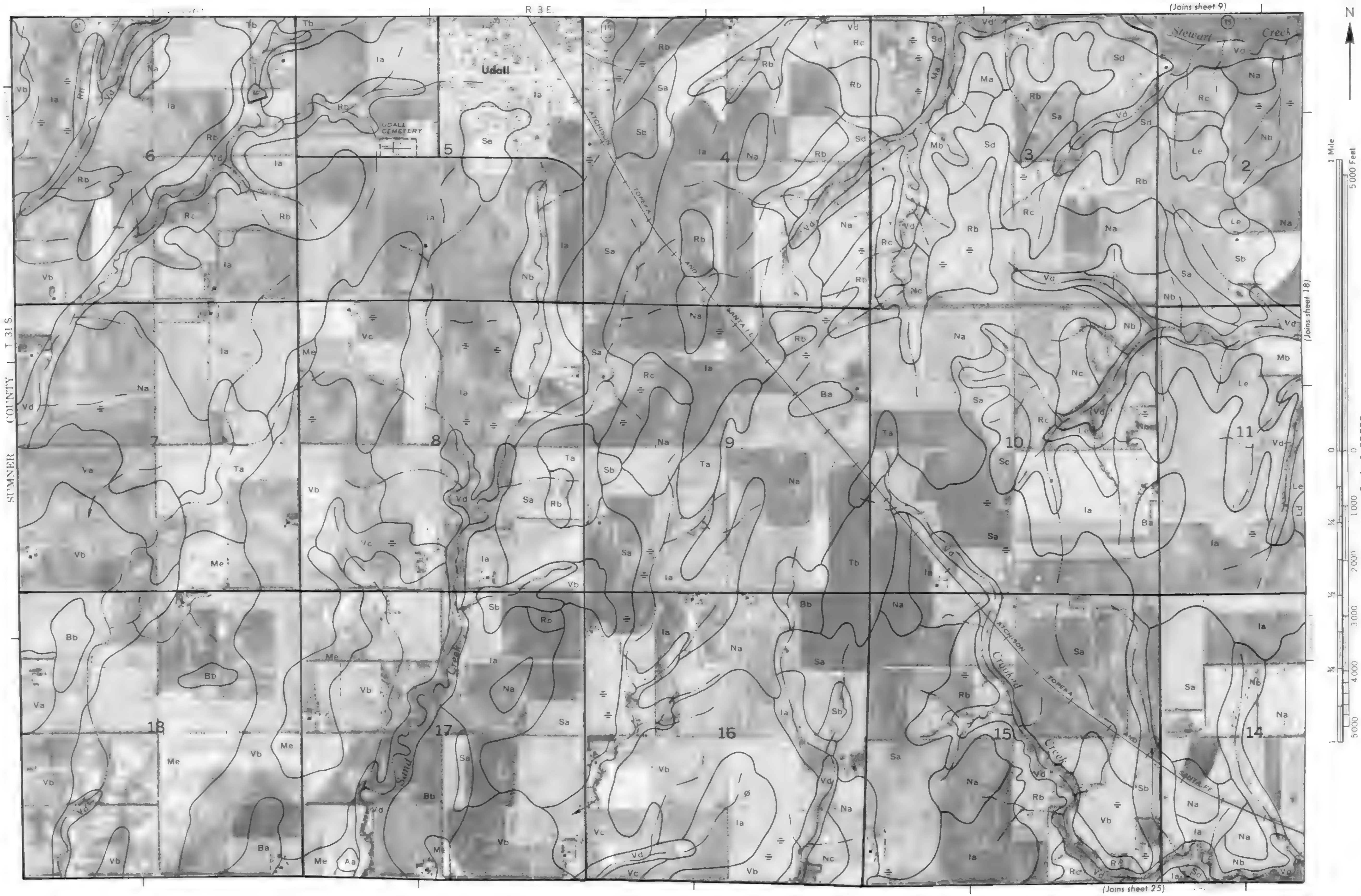
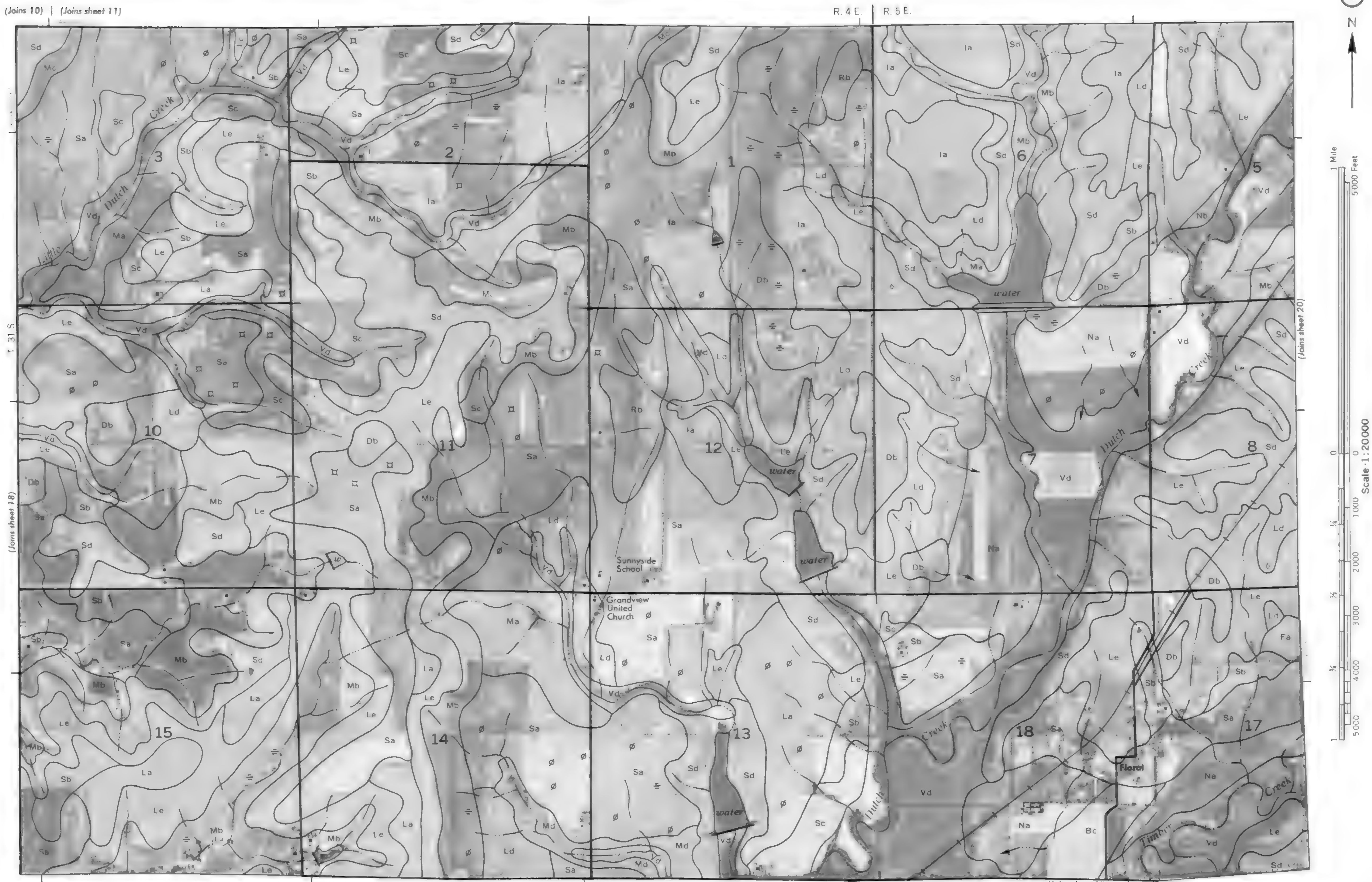

R 3 E.
T 31 S.
SUMNER COUNTY
(Joins sheet 9)
(Joins sheet 18)
(Joins sheet 25)
Udall
UDALL CEMETERY
Stewart Creek
Sand Creek
Crooked Creek
ATCHISON TOPEKA AND SANTA FE
N
1 Mile
5000 Feet
Scale 1:20000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

COWLEY COUNTY, KANSAS — SHEET NUMBER 18



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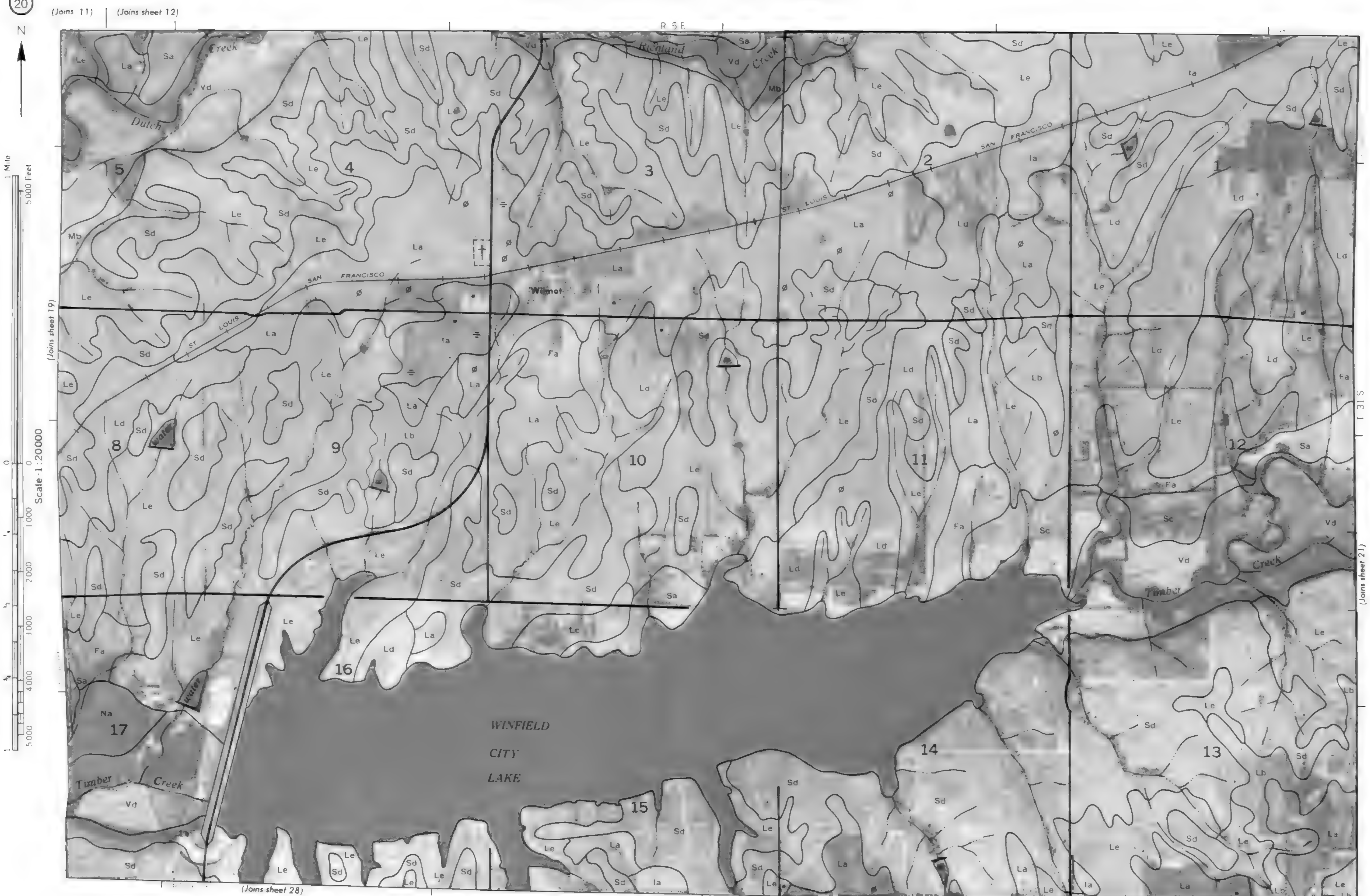
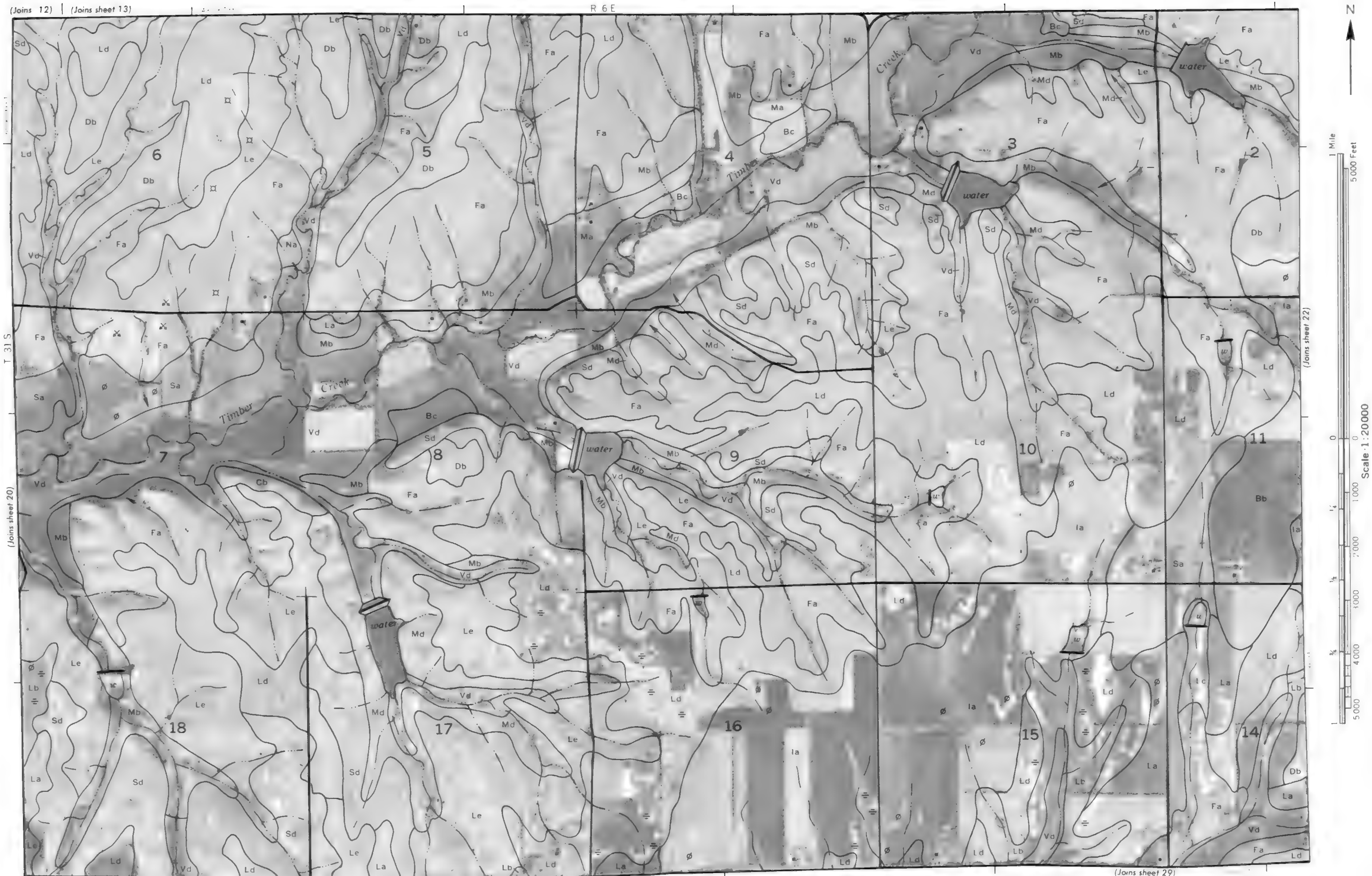
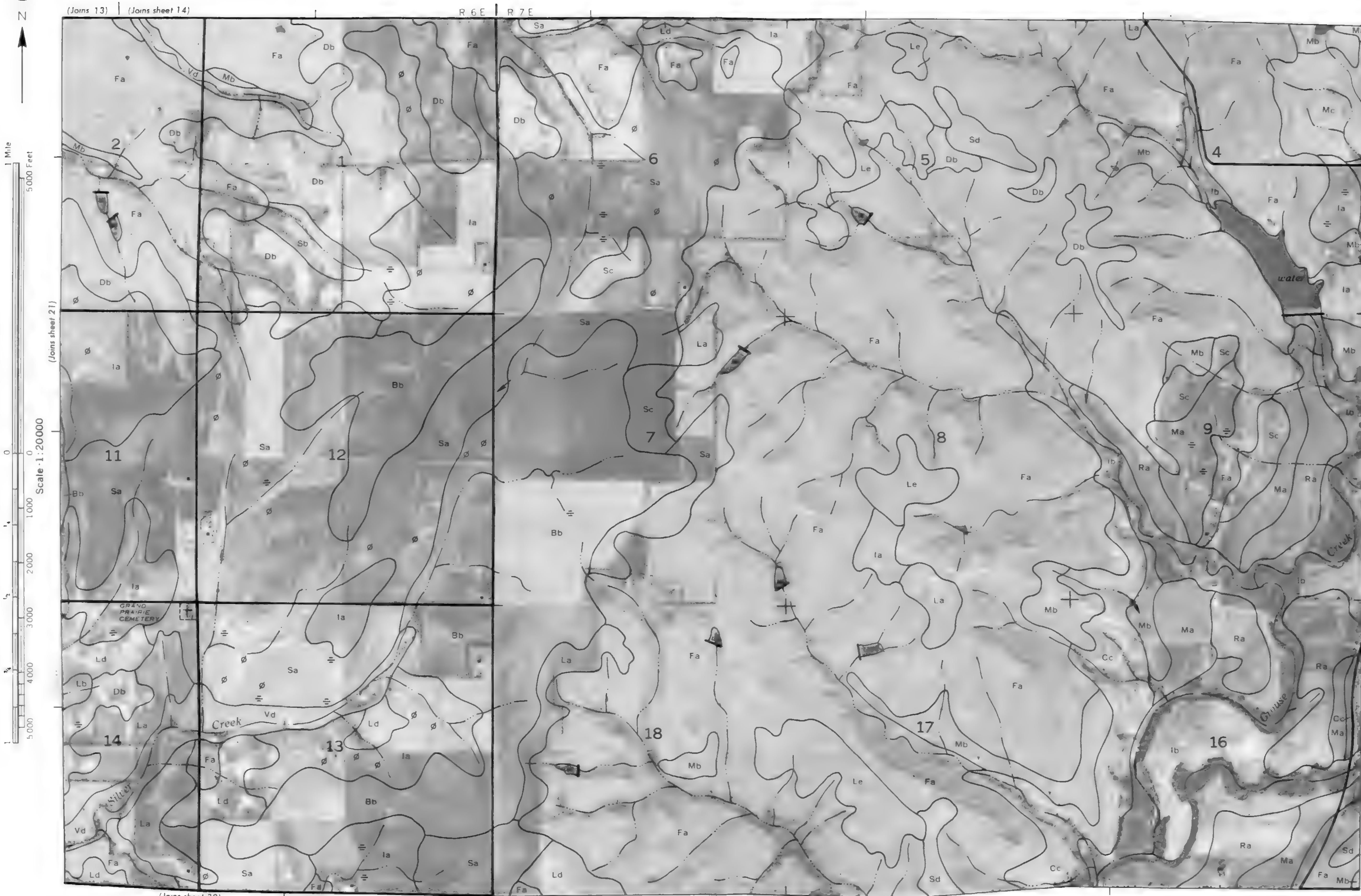
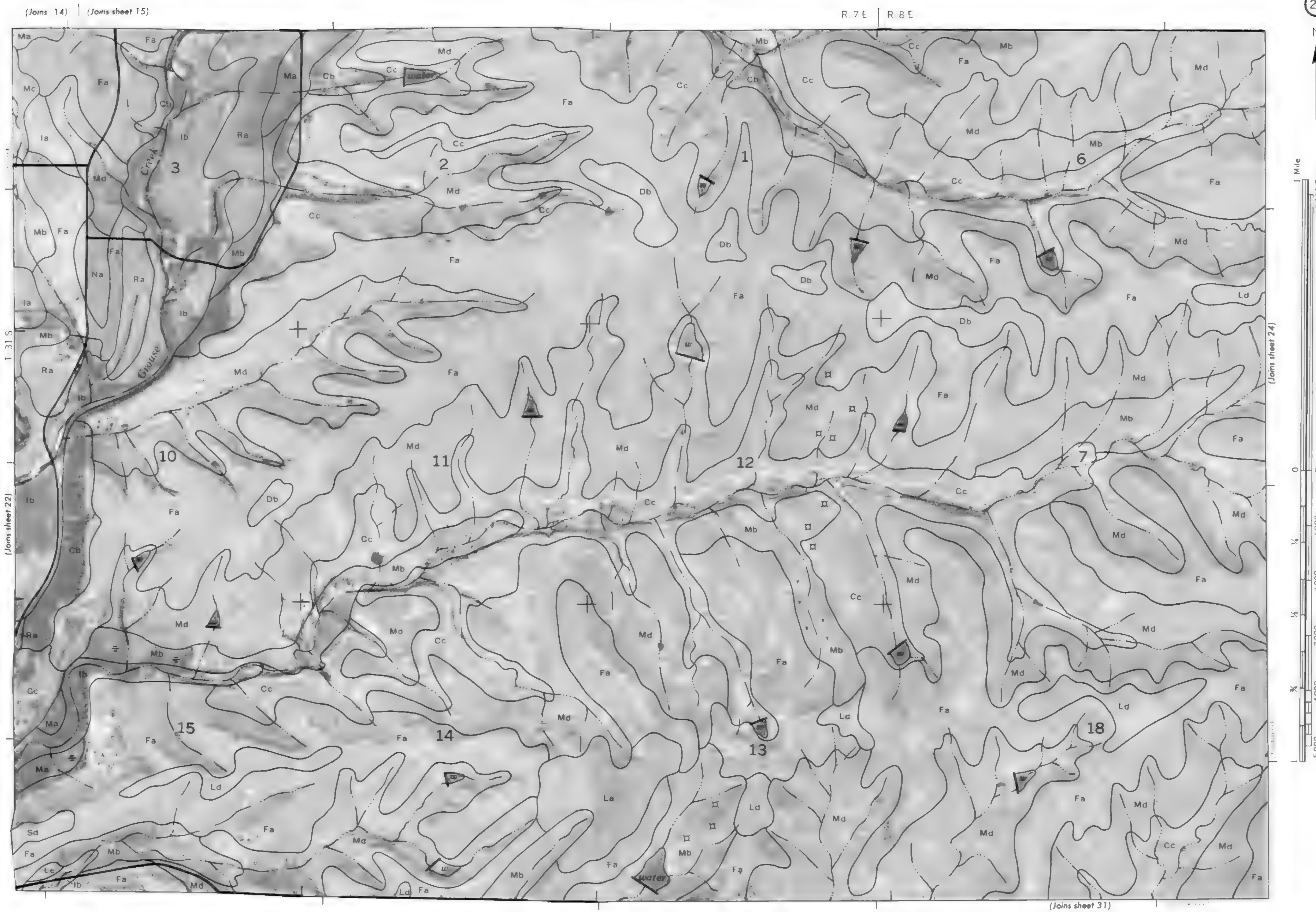
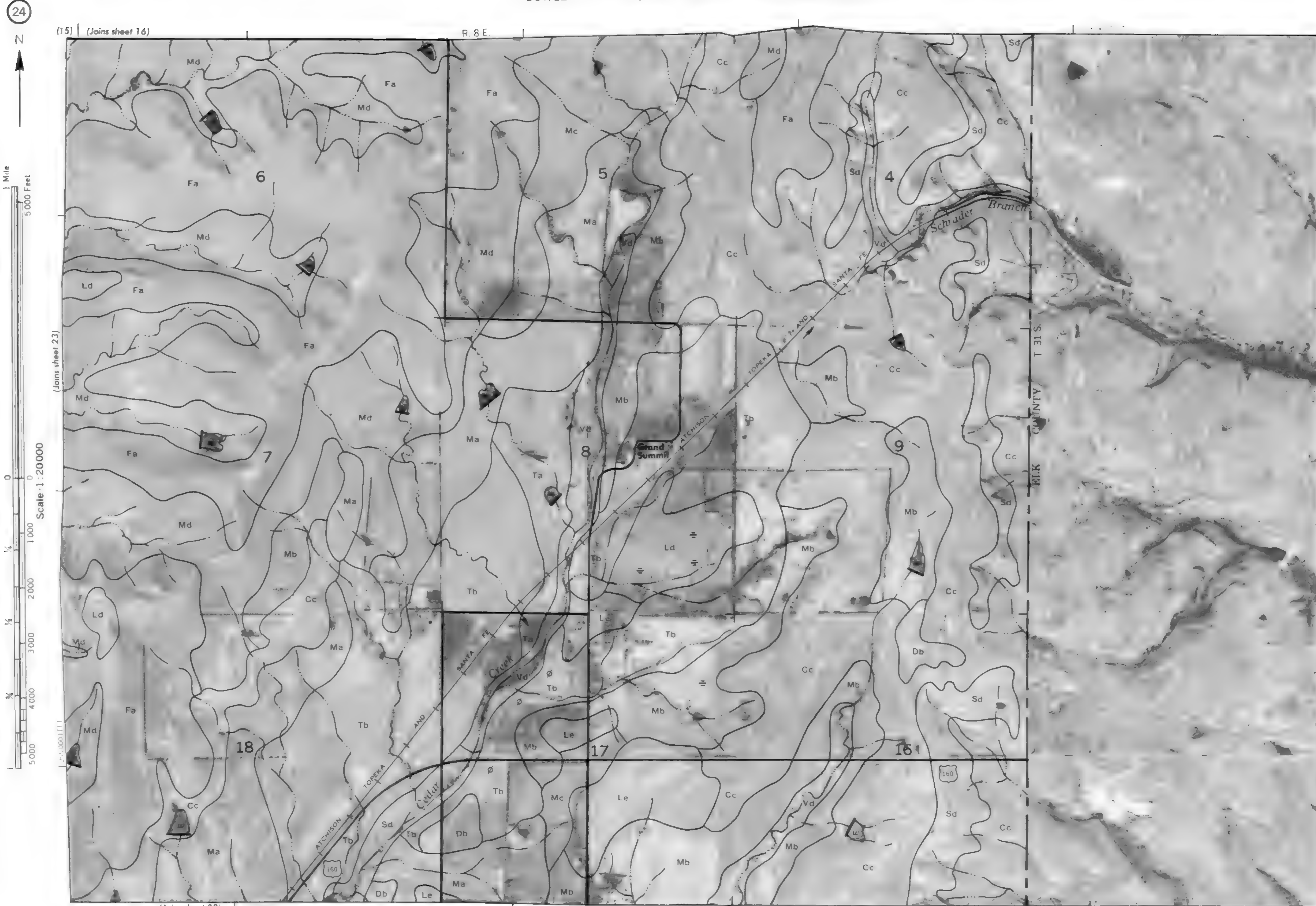
COWLEY COUNTY, KANSAS — SHEET NUMBER 20




(Joins 12)
(Joins sheet 13)
R 6 E
T 31 S
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 29)
Timber Creek
Timber
Creek
water
N
1 Mile
5000 Feet
Scale 1:20000
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

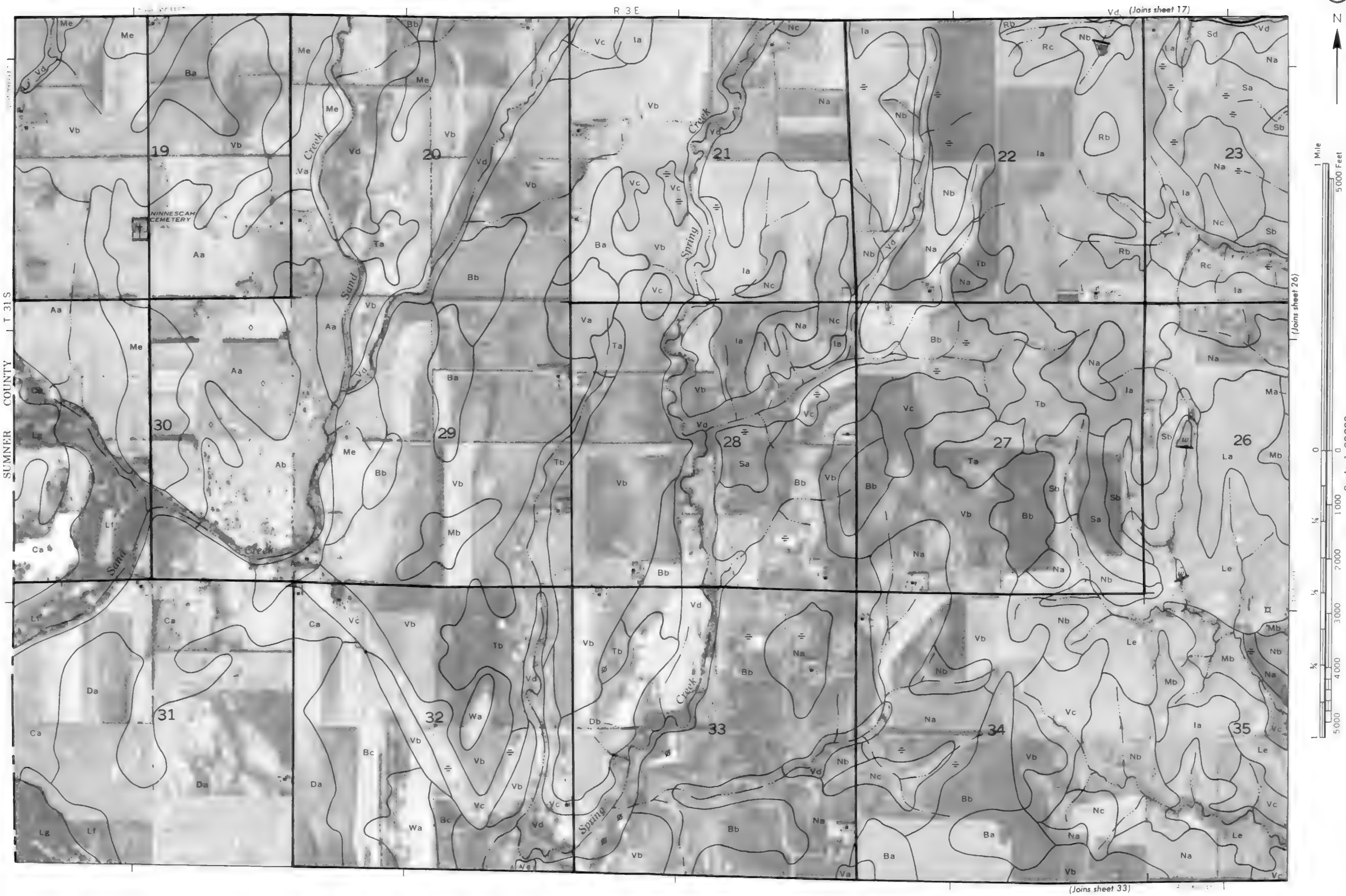

N
(Joins 13)
(Joins sheet 14)
R 6 E
R 7 E
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 30)
T 31 S
1 Mile
5000 Feet
Scale 1:20000
GRAND PRAIRIE CEMETERY
water
Silver
Creek
Grouse
Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

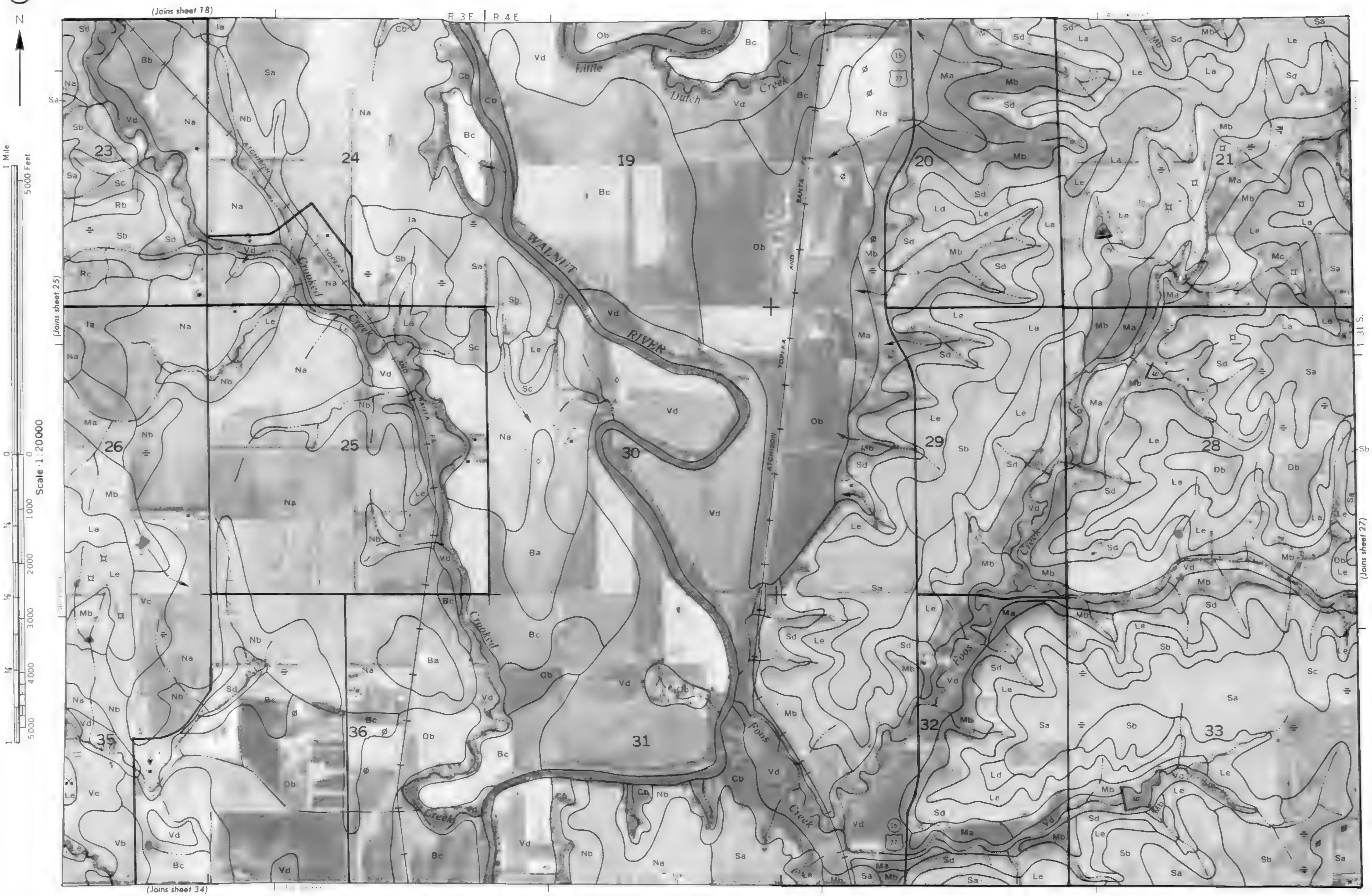

(Joins 14)
(Joins sheet 15)
R.7 E.
R.8 E.
23
N
T. 31 S.
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 31)
Grouse Creek
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
2
3
6
7
10
11
12
13
14
15
18
Ma
Mb
Mc
Md
Fa
Cb
Cc
Ia
Ib
Ra
Na
Db
Ld
La
Le
Sd



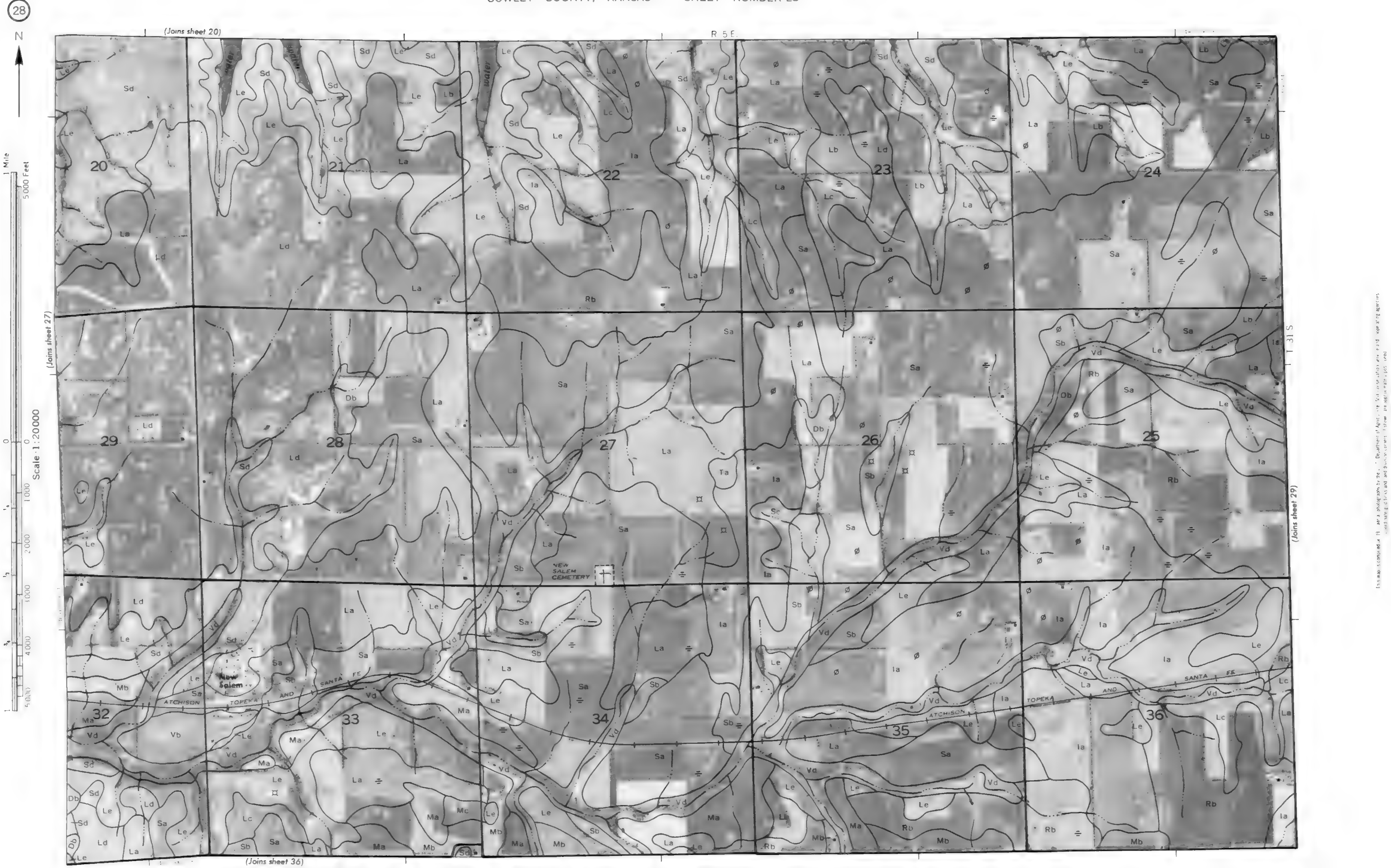
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

COWLEY COUNTY, KANSAS — SHEET NUMBER 25

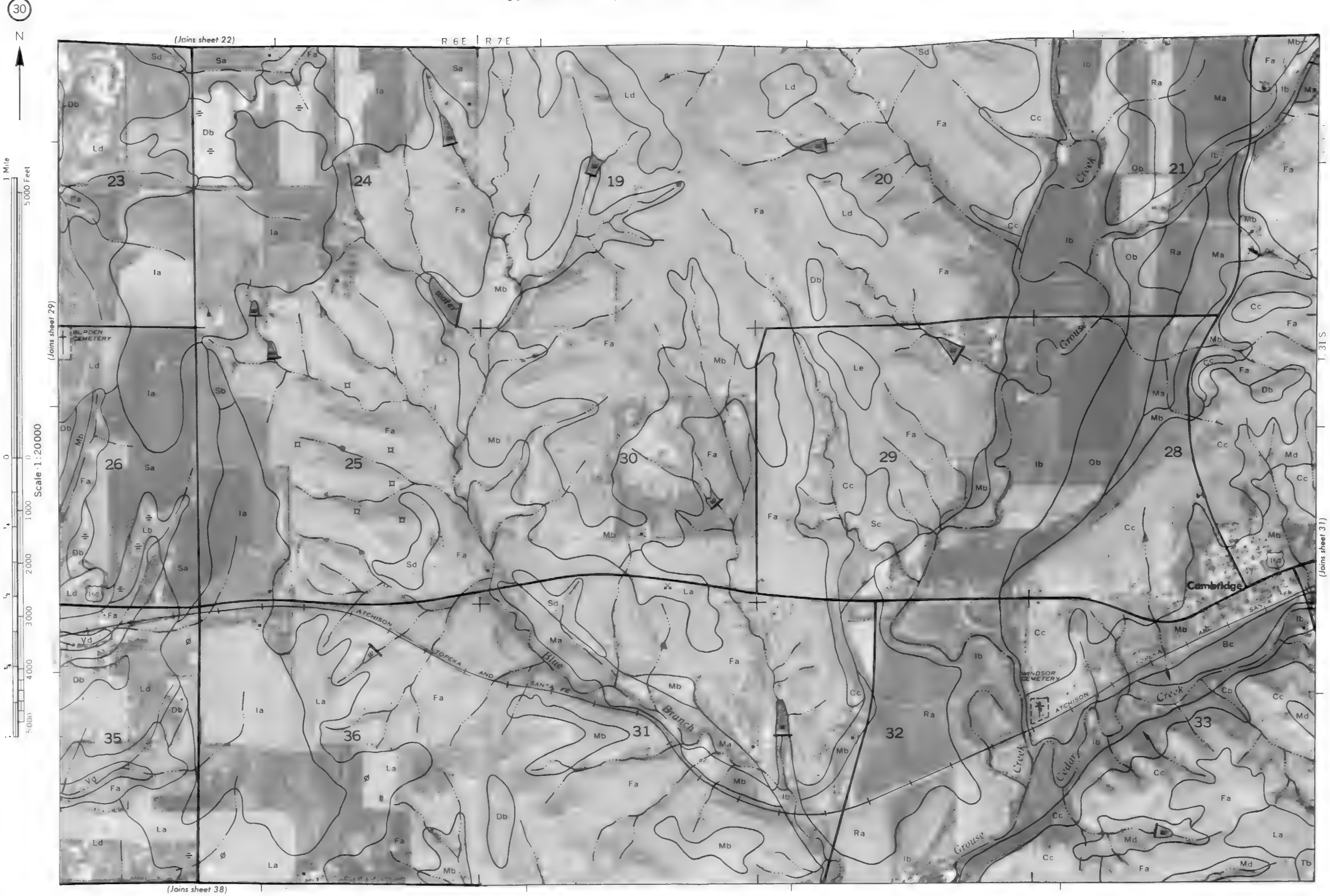


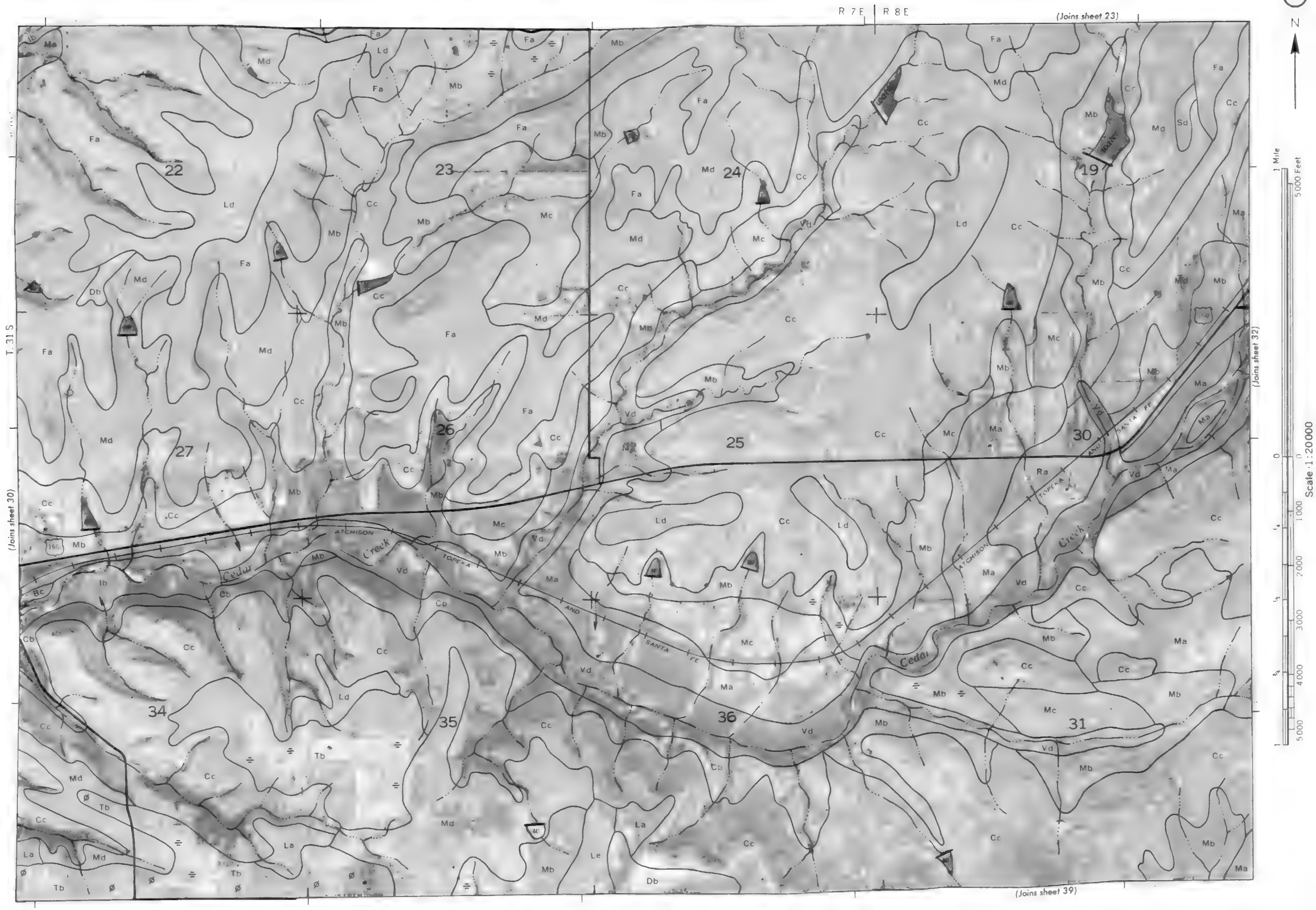

N
(Joins sheet 18)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 34)
R 3 E
R 4 E
T 31 S.
1 Mile
5000 Feet
Scale 1:20000
WALNUT RIVER
Crooked Creek
Little Dutch Creek
Foos Creek
ATCHISON TOPEKA AND SANTA FE
15
77
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

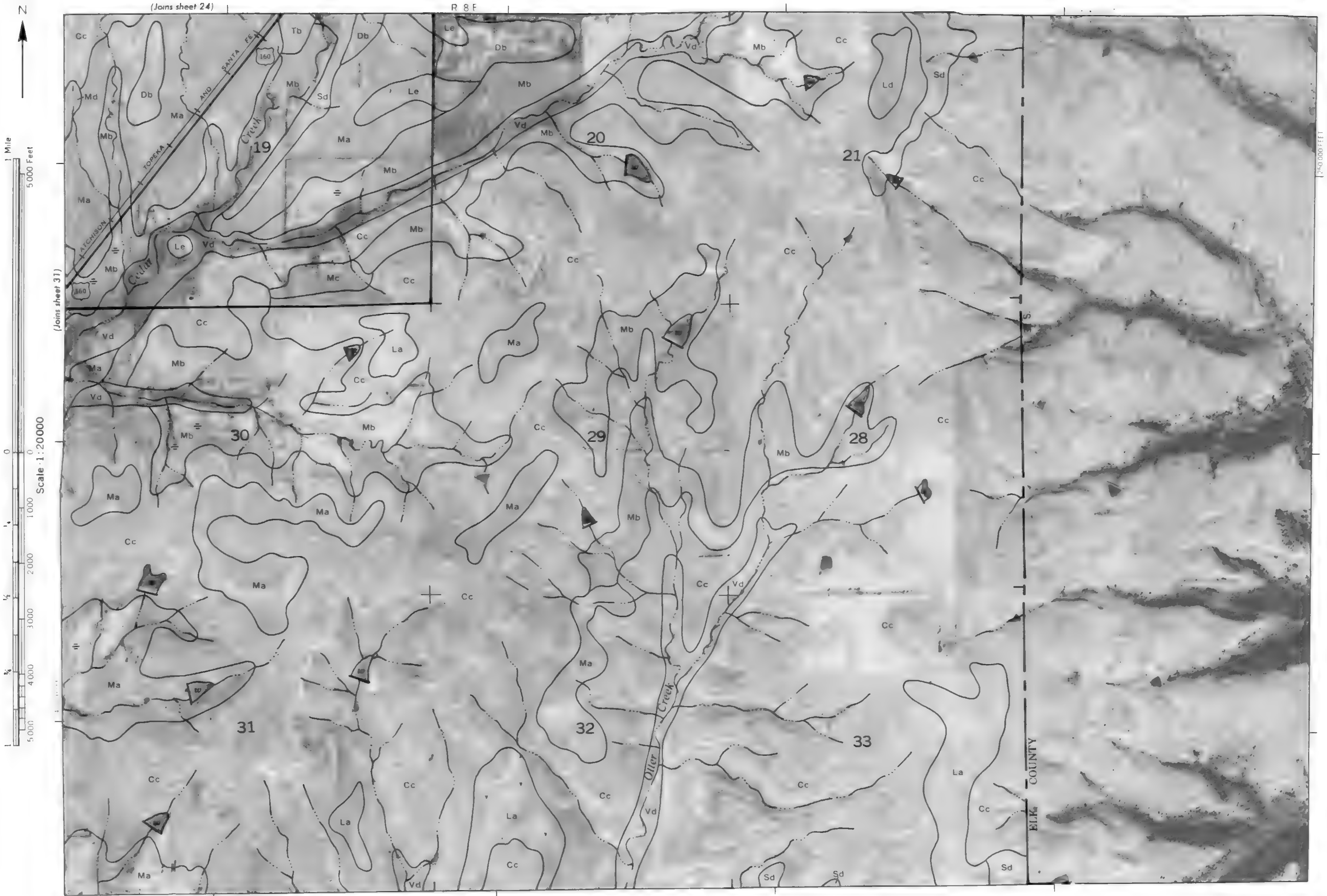

R 4 E. | R 5 E.
(Joins sheet 19)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 35)
T 31 S
N
1 Mile
5000 Feet
Scale 1:20000
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Dutch Creek
Timber Creek
Cedar Creek
Cedar Cr
ST. LOUIS SAN FRANCISCO
ATCHISON TOPEKA AND SANTA FE
water


28
N
(Joins sheet 20)
R 5 E
T 31 S
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 36)
1 Mile
5000 Feet
Scale 1:20 000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
NEW SALEM CEMETERY
New Salem
ATCHISON
TOPEKA
AND
SANTA FE
Water

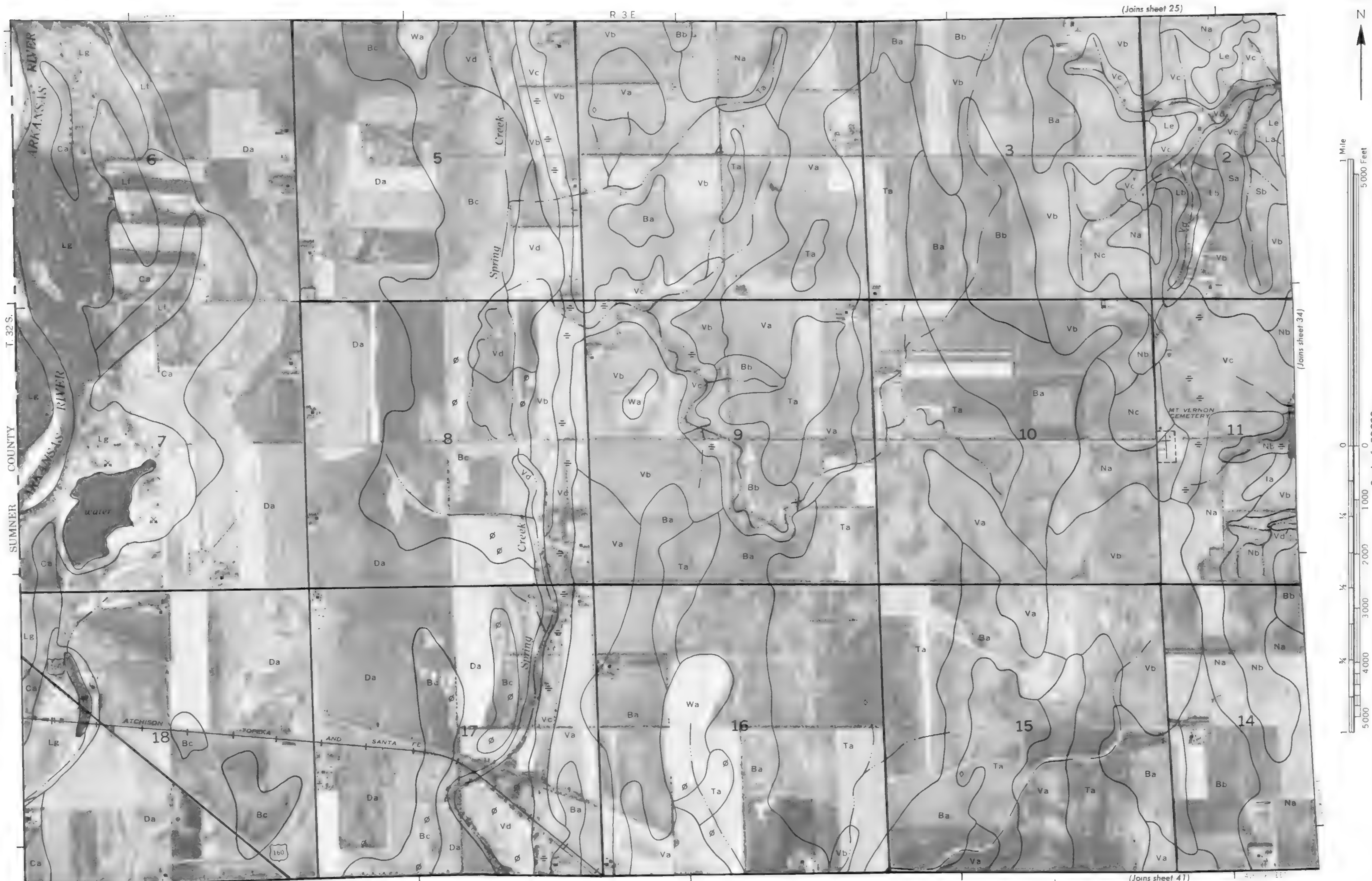

(Joins sheet 21)
(Joins sheet 30)
(Joins sheet 37)
(Joins sheet 28)
N
Scale 1:20000
1 Mile
5000 Feet
T. 31 S.
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
BURDEN CEMETERY
Burden
Silver Creek
Plum Creek
ATCHISON TOPEKA AND SANTA FE
water

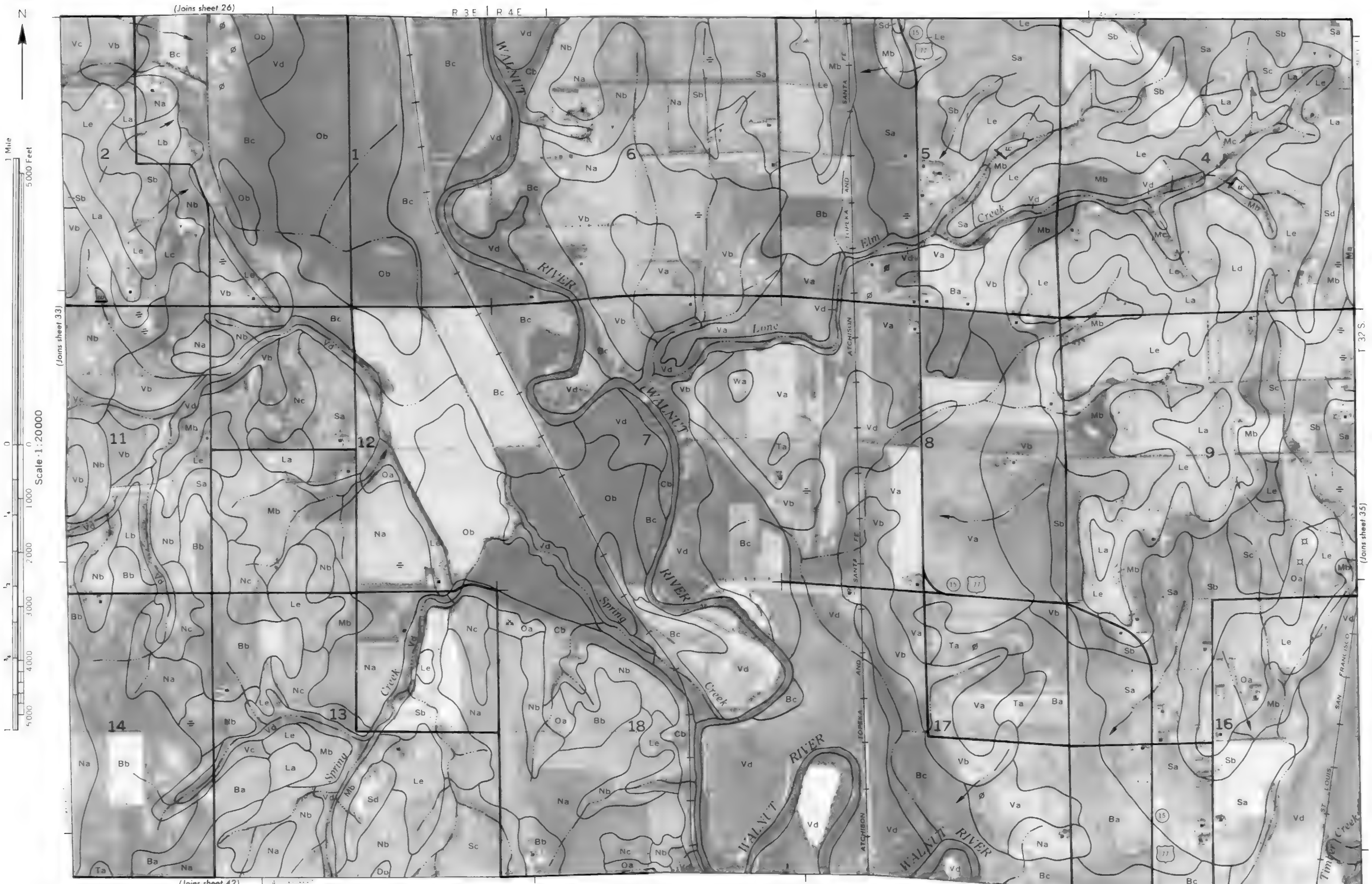

30
N
(Joins sheet 22)
R 6 E
R 7 E
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 38)
T. 31 S.
1 Mile
5000 Feet
Scale 1:20000
BURDEN CEMETERY
WINDSOR CEMETERY
Cambridge
ATCHISON TOPEKA AND SANTA FE
Blue Branch
Grouse Creek
Cedar Creek
water
160
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

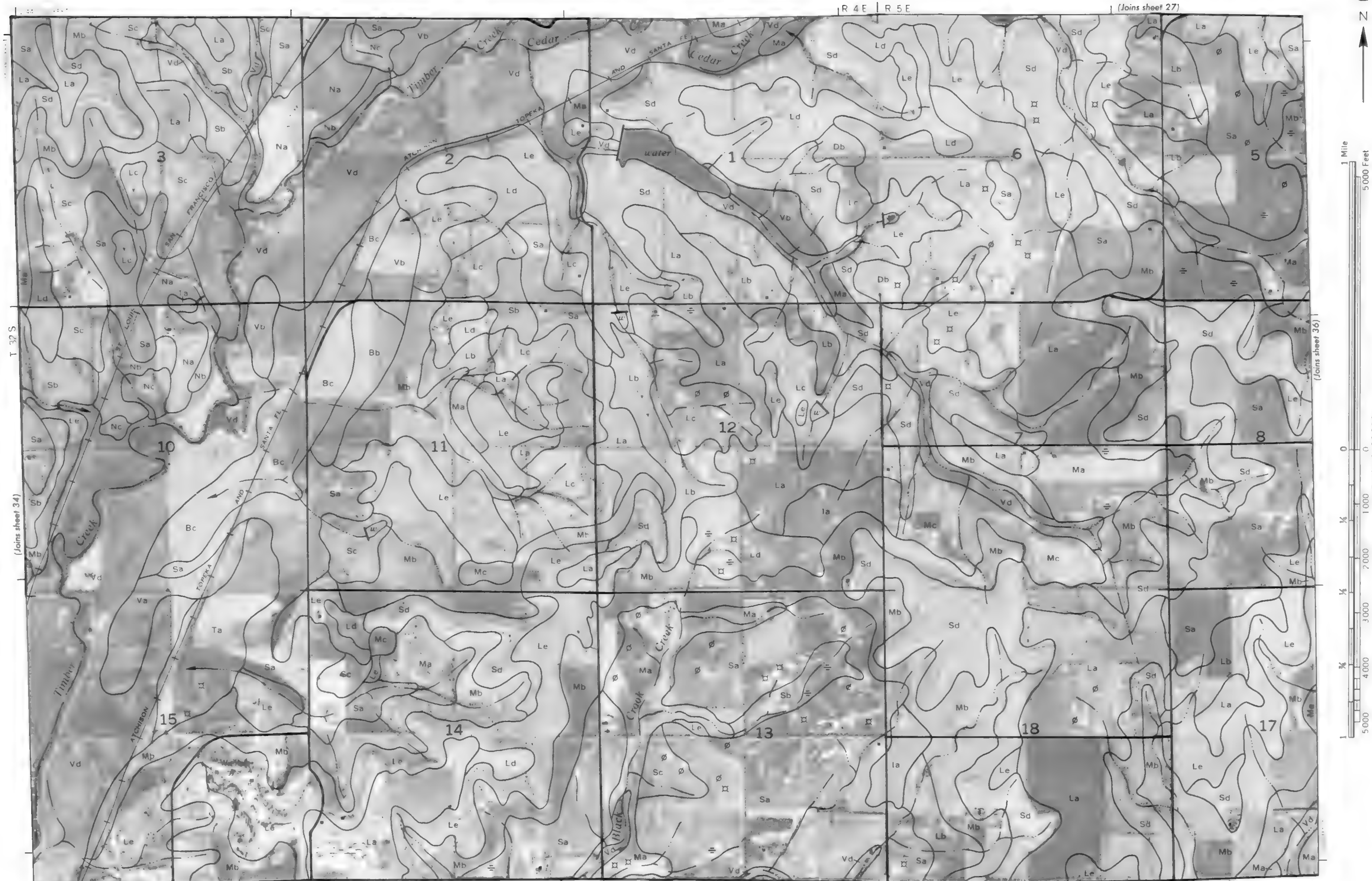

R 7 E
R 8 E
(Joins sheet 23)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 39)
T. 31 S
N
1 Mile
5000 Feet
Scale 1:20000
22
23
24
19
27
26
25
30
34
35
36
31
Cedar Creek
ATCHISON TOPEKA AND SANTA FE
water

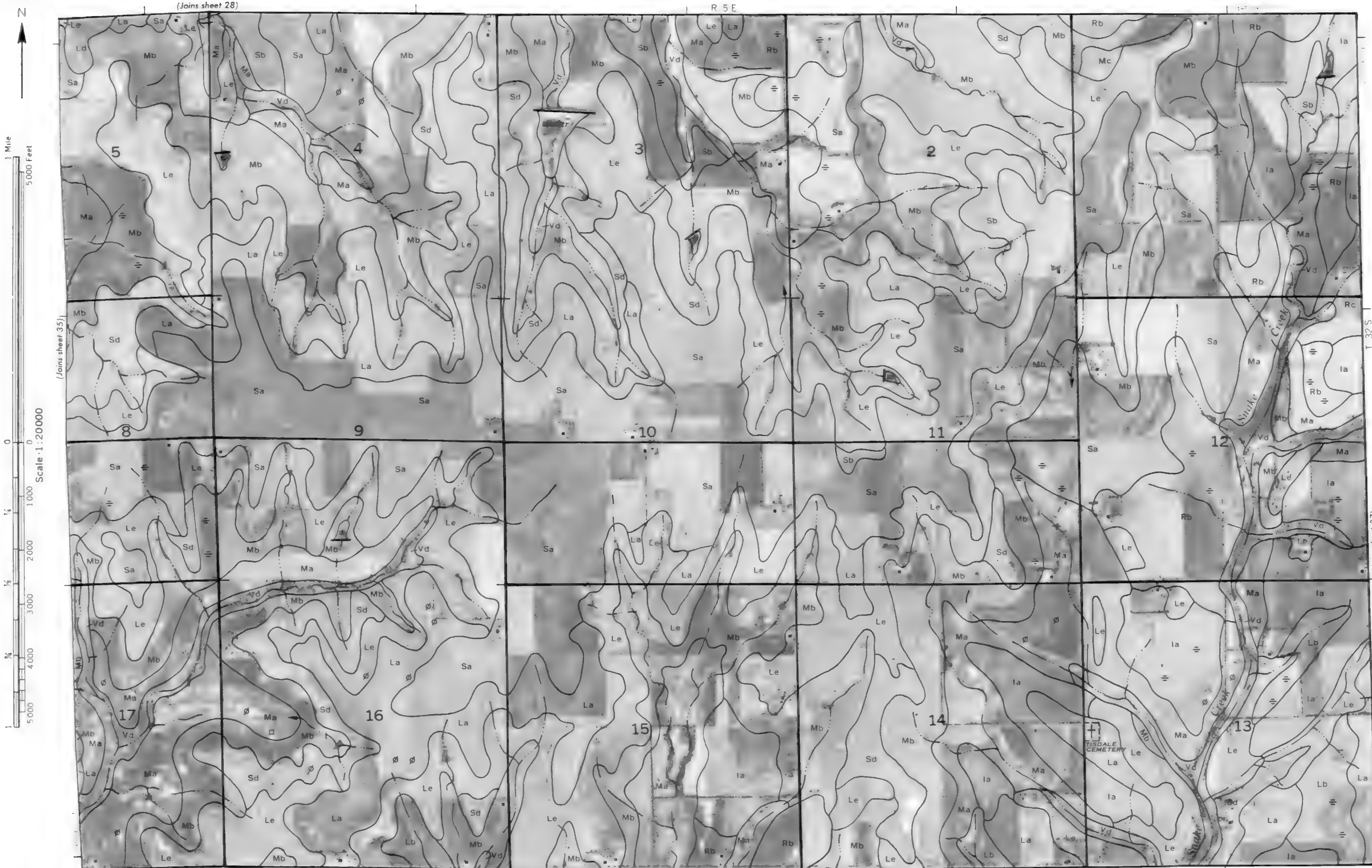

N
(Joins sheet 24)
R 8 E
(Joins sheet 31)
(Joins sheet 40)
1 Mile
5000 Feet
Scale 1:20000
ATCHISON TOPEKA AND SANTA FE
160
Cedar Creek
Otter Creek
ELK COUNTY
19
20
21
28
29
30
31
32
33
Cc
Db
Le
Tb
Md
Mb
Ma
Sd
Vd
Mc
Ld
La

COWLEY COUNTY, KANSAS — SHEET NUMBER 33

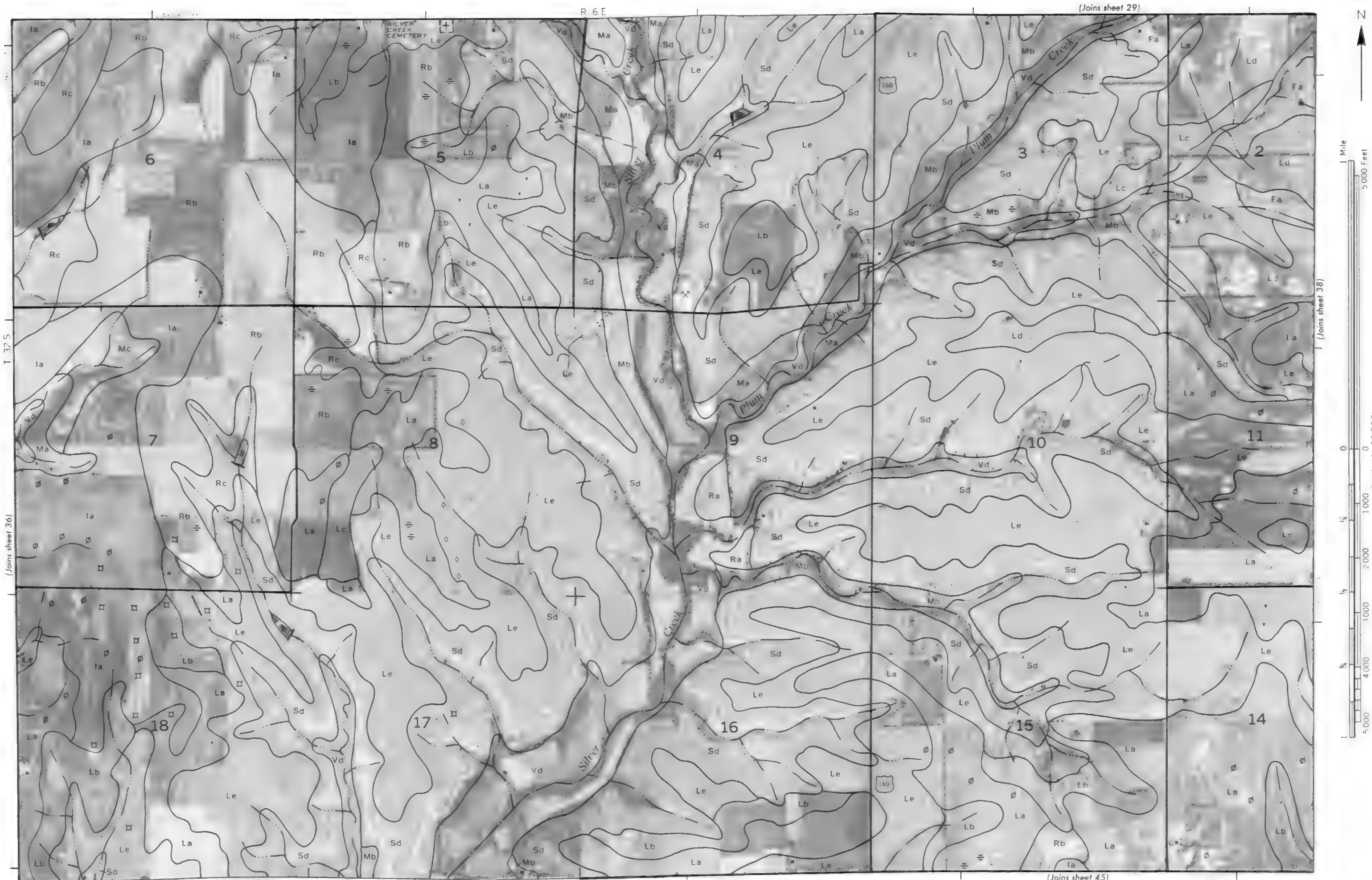



N
(Joins sheet 26)
R 3 E | R 4 E
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 42)
T 32 S.
Scale 1:20000
1 Mile
5000 Feet
WALNUT RIVER
Elm Creek
Lone
Spring Creek
Timber Creek
SANTA FE
ATCHISON TOPEKA AND SANTA FE
ST. LOUIS SAN FRANCISCO

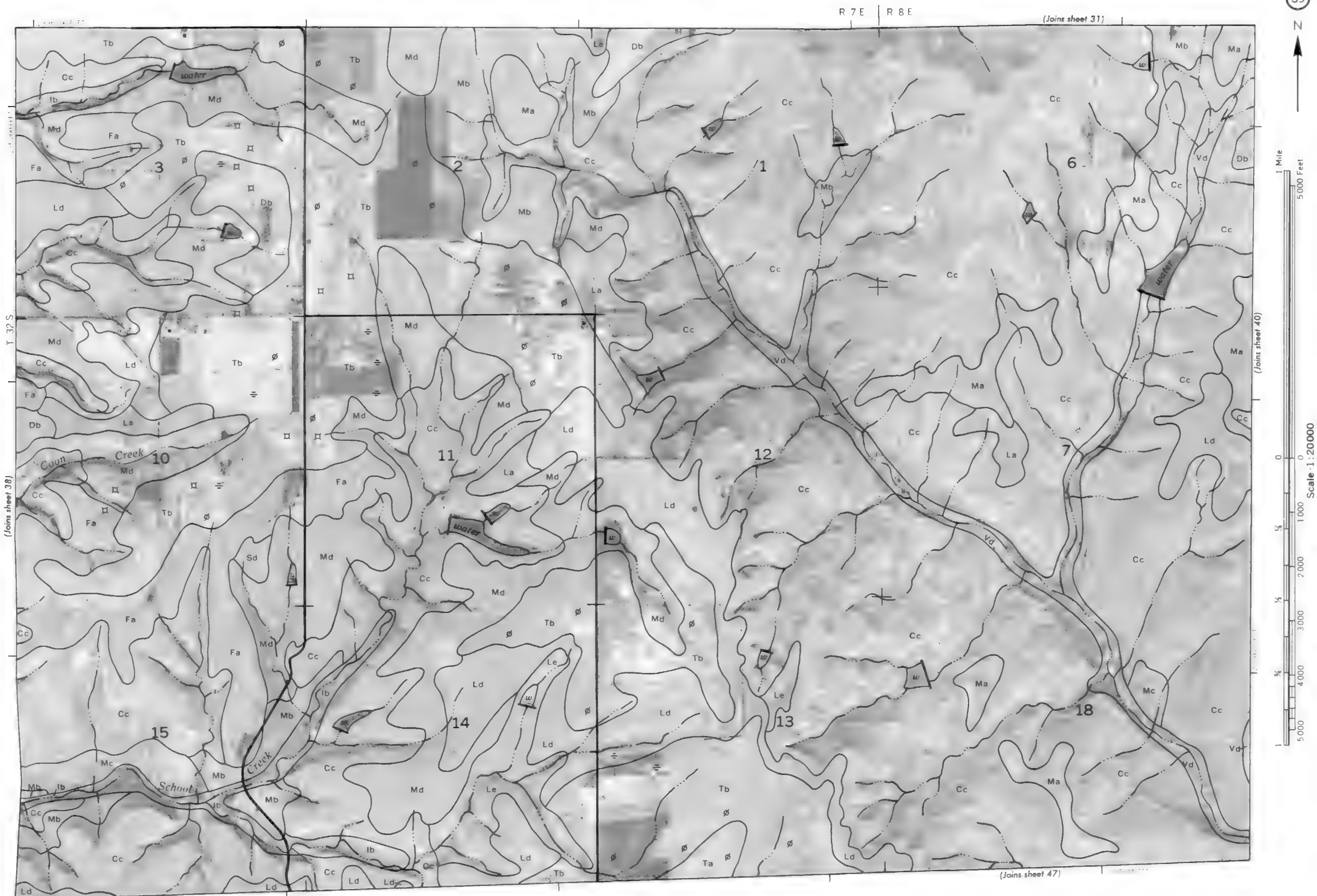

(Joins sheet 27)
(Joins sheet 36)
(Joins sheet 43)
(Joins sheet 34)
R 4 E
R 5 E
T 32 S
N
1 Mile
5000 Feet
Scale 1:20000
water
Cedar Creek
Timber Creek
Black Crook Creek
ATCHISON TOPEKA AND SANTA FE
ST LOUIS SAN FRANCISCO


N
(Joins sheet 28)
R 5 E
T 32 S
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 44)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
TISDALE CEMETERY
Snake Creek
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

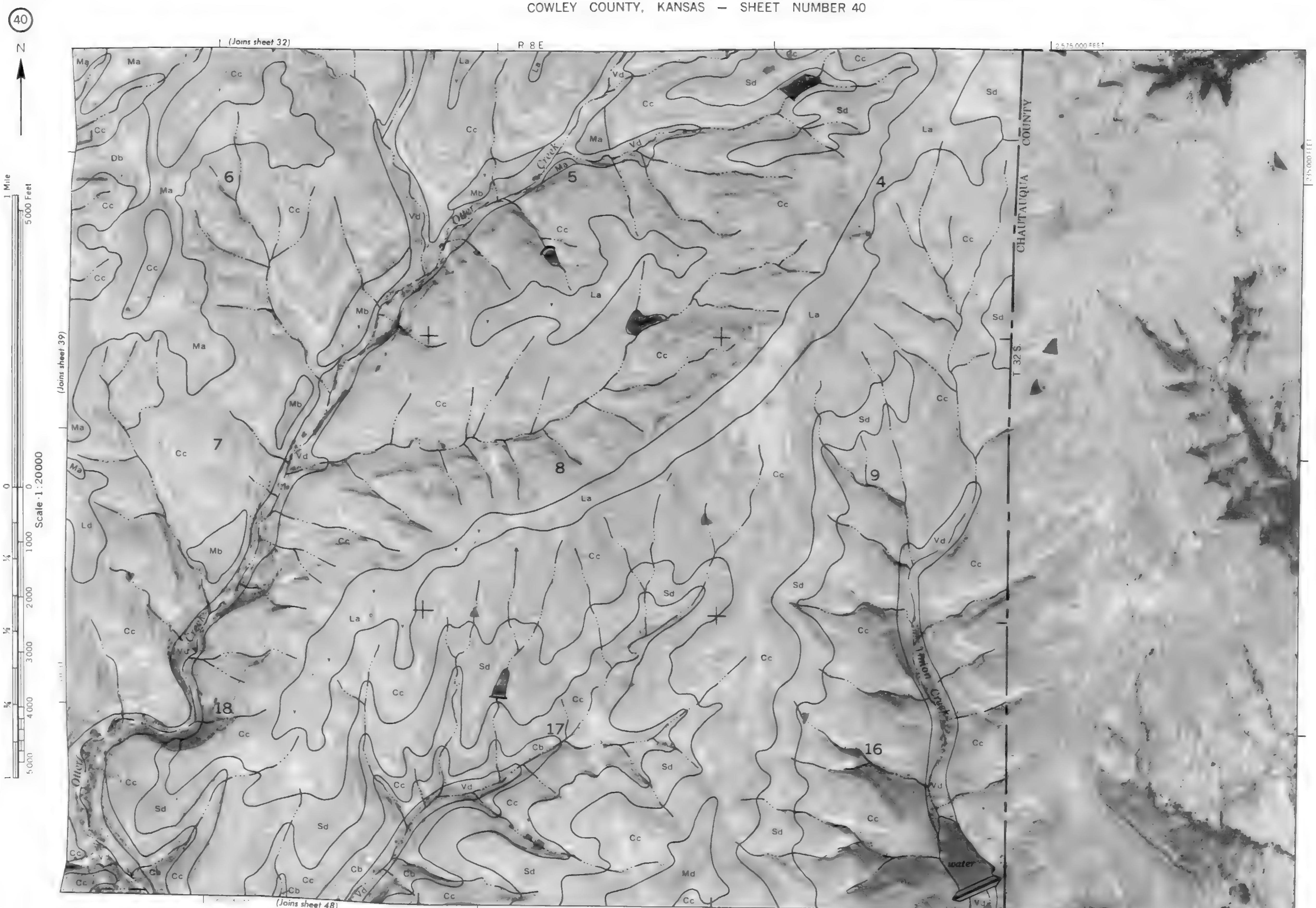
COWLEY COUNTY, KANSAS — SHEET NUMBER 37



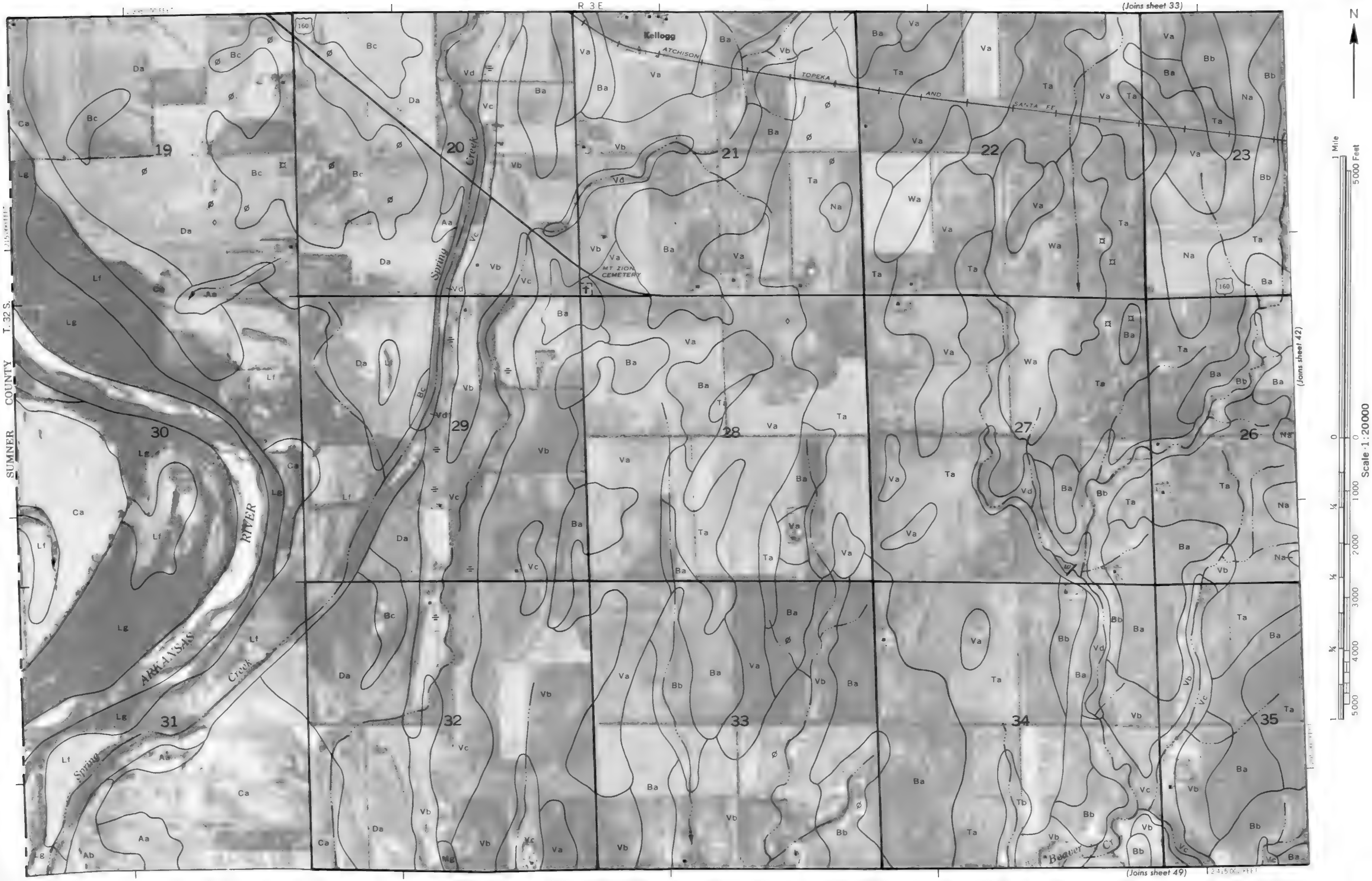

N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 30)
R 6 E | R 7 E
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 46)
T 32 S
Blue Branch Creek
Coon Creek
School Creek
Grouse Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



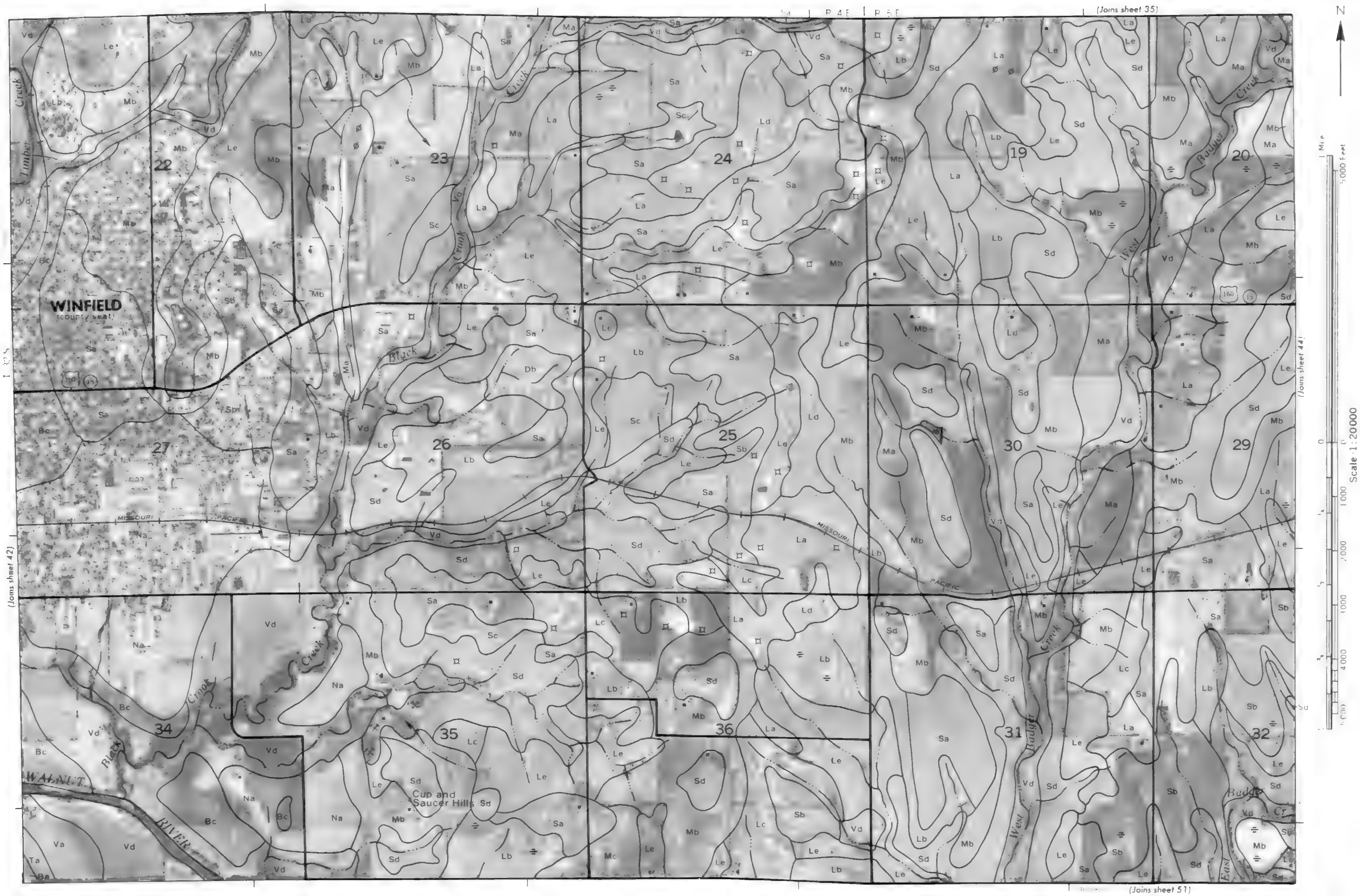
This map is compiled on 1971 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



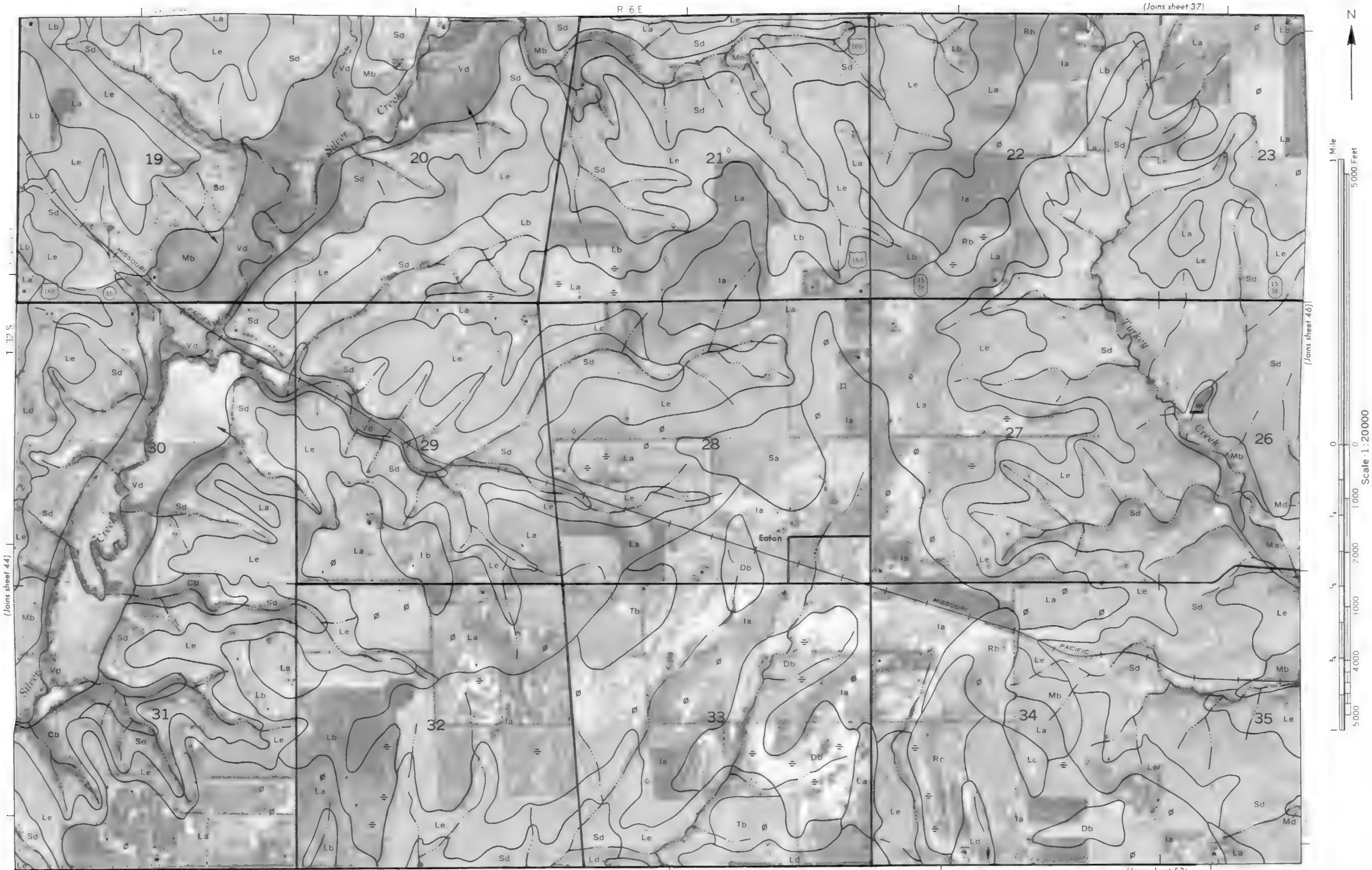
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

COWLEY COUNTY, KANSAS — SHEET NUMBER 42

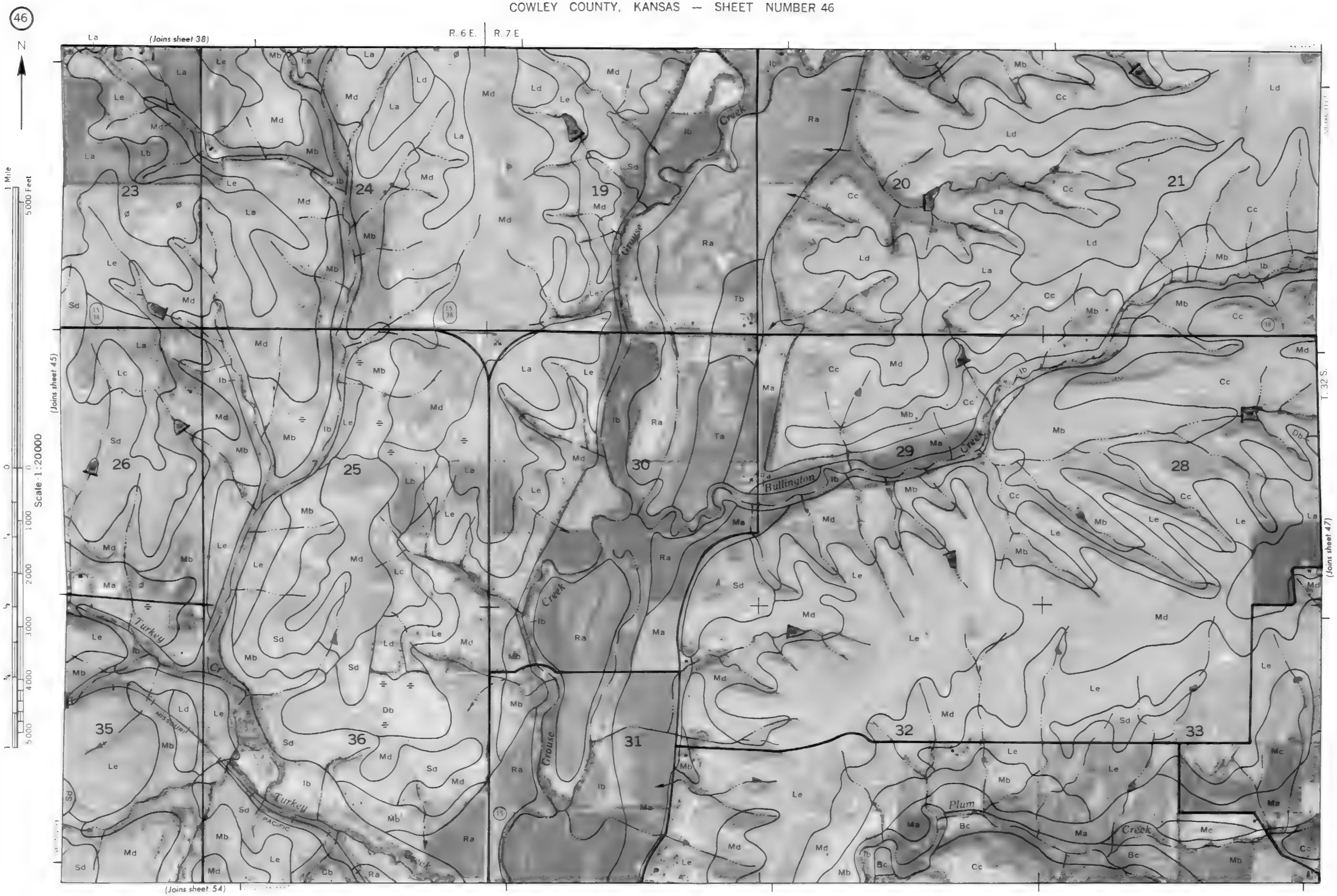
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

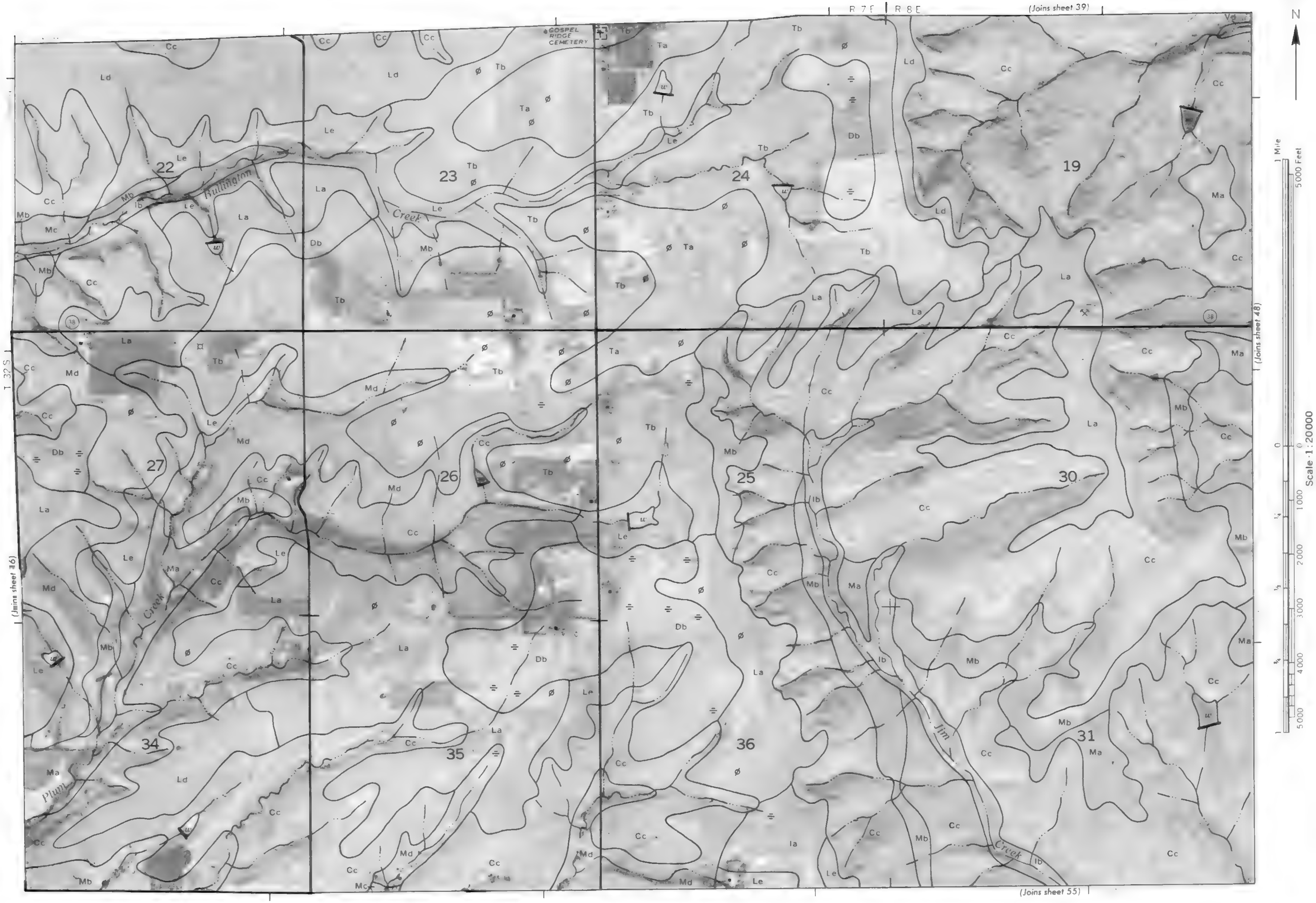

(Joins sheet 35)
R 4 E
R 5 E
N
WINFIELD
(county seat)
Timber Creek
Black Creek
Black Crook
Crook
Creek
Badger Creek
West Badger Creek
West
Badger Cr
East
WALNUT RIVER
MISSOURI PACIFIC
Cup and Saucer Hills
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
160
15
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 51)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

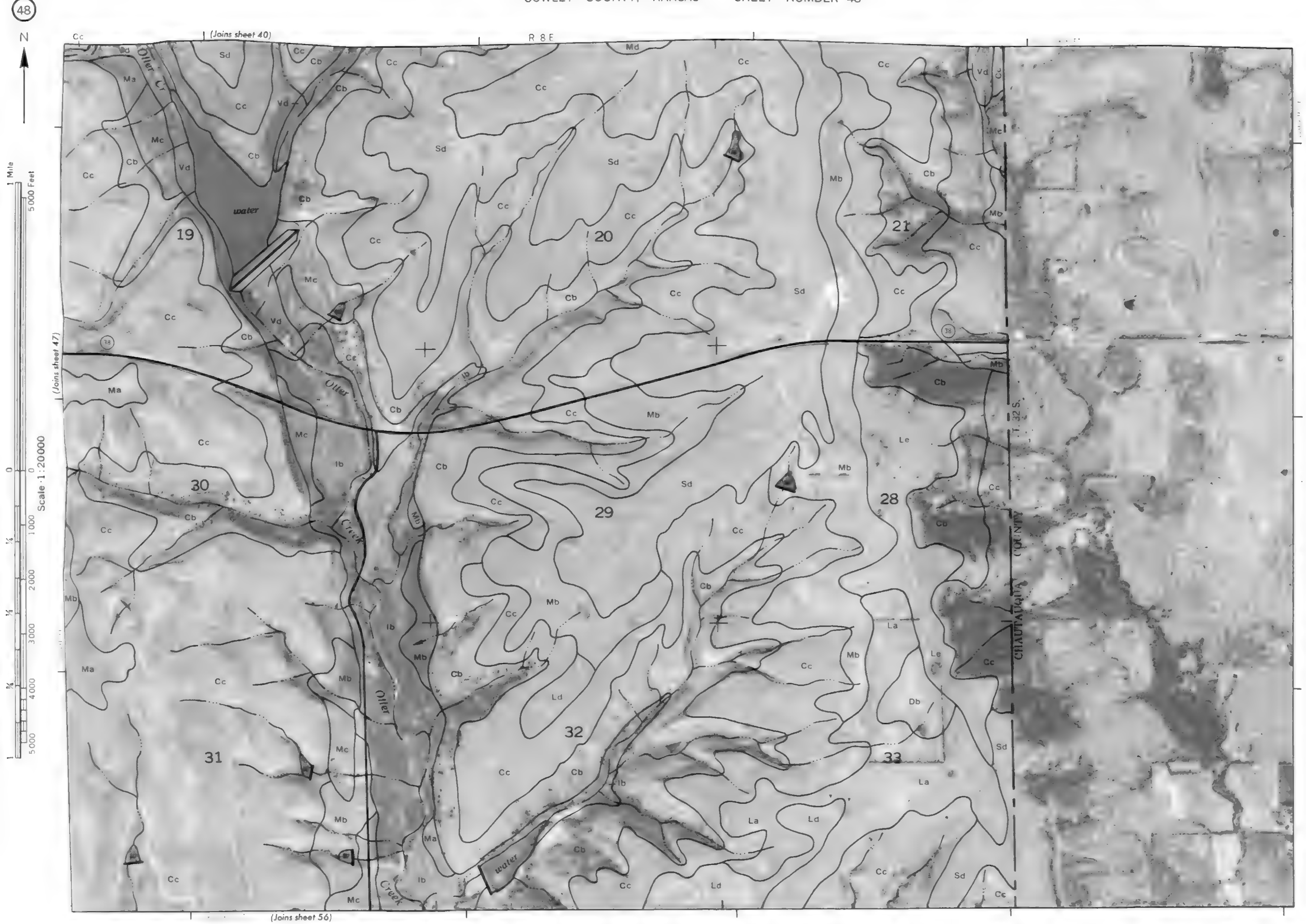

N
(Joins sheet 36)
R 5 E
(Joins sheet 43)
(Joins sheet 45)
T 32 S
(Joins sheet 52)
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
Tisdale
MISSOURI
PACIFIC
Badger
Creek
Snake
Creek
East
Cr
Silver
Creek


R 6 E
(Joins sheet 37)
(Joins sheet 46)
(Joins sheet 53)
(Joins sheet 44)
T 32 S
N
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
Silver Creek
Turkey Creek
MISSOURI PACIFIC
Eaton
160
15
38
Lb
La
Le
Sd
Vd
Mb
Md
Ma
Ld
Lc
Cb
Rb
Rc
Db
Tb
Sa
Ia
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

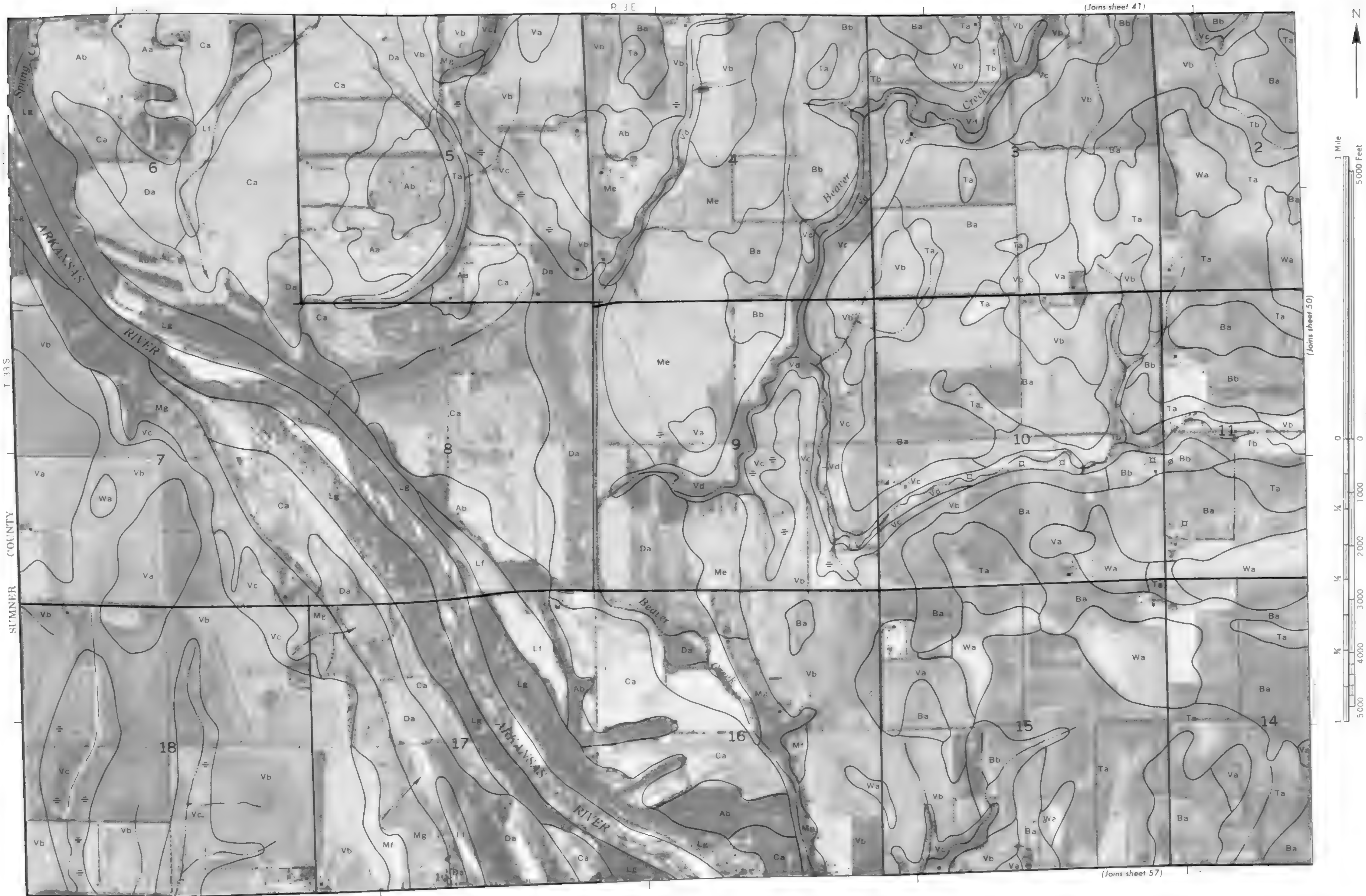
COWLEY COUNTY, KANSAS — SHEET NUMBER 46



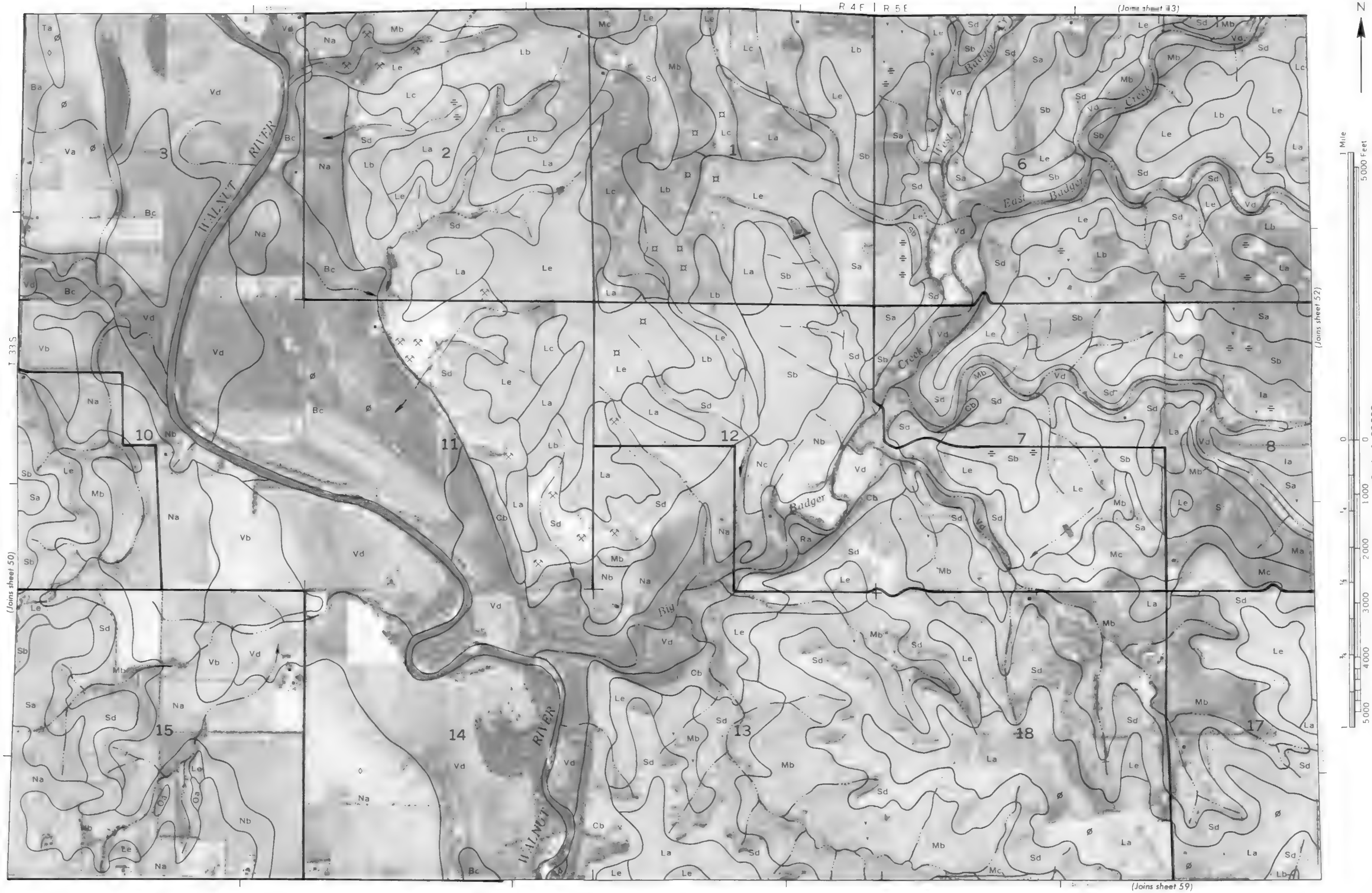

47
N
R 7 E
R 8 E
(Joins sheet 39)
(Joins sheet 48)
(Joins sheet 46)
(Joins sheet 55)
T 32 S
GOSPEL RIDGE CEMETERY
Bullington Creek
Creek
Plum
Jim Creek
22
23
24
19
27
26
25
30
34
35
36
31
38
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20000



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

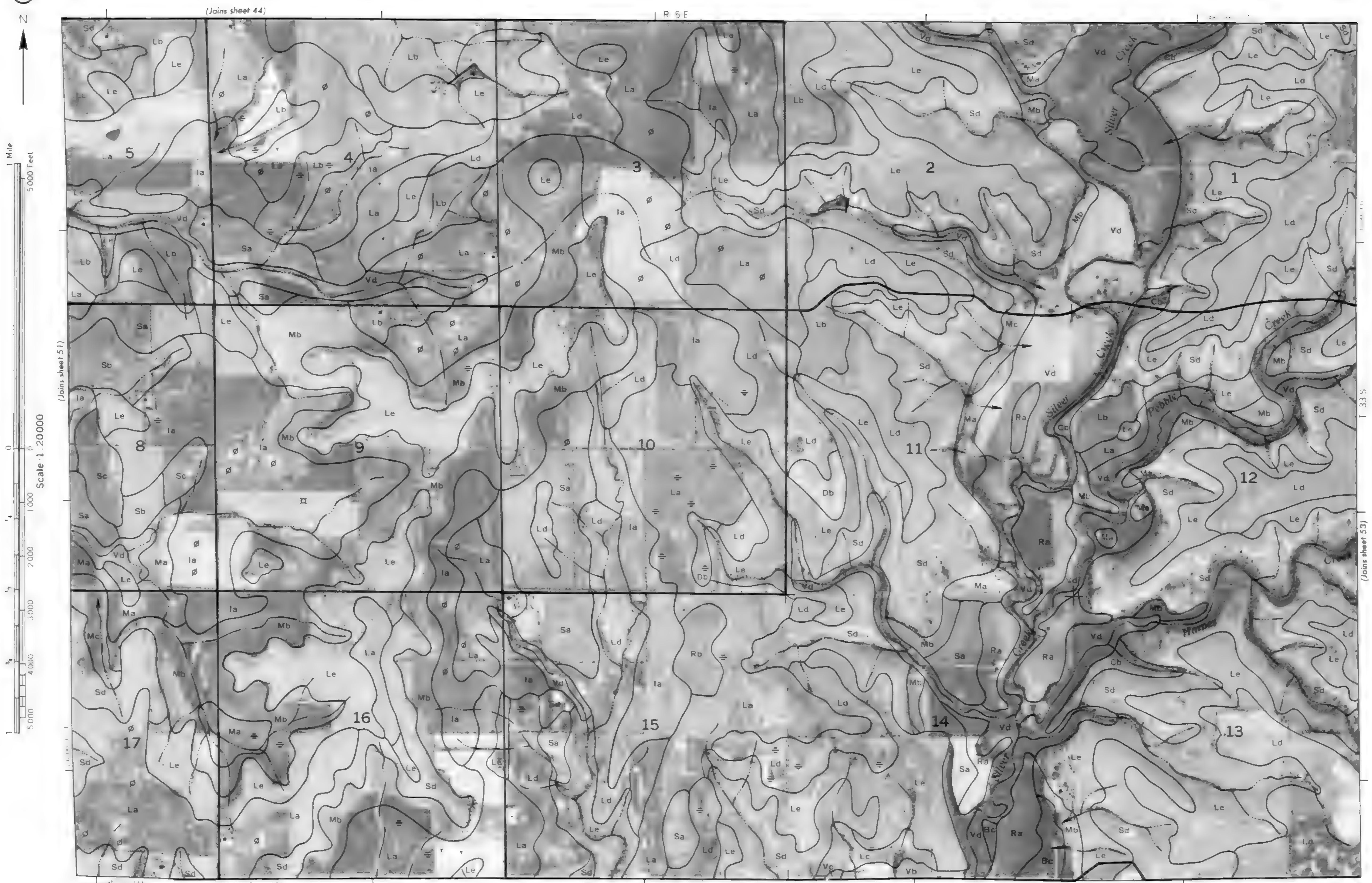

(Joins sheet 41)
(Joins sheet 50)
(Joins sheet 57)
R 3 E
T 33 S
SUMNER COUNTY
ARKANSAS RIVER
Spring Cr.
Beaver Creek
Creek
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18


50
N
(Joins sheet 42)
R. 3 E
R. 4 E
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 58)
T. 33 S.
1 Mile
5000 Feet
Scale 1:20000
ST LOUIS SAN FRANCISCO
ATCHISON TOPEKA AND SANTA FE
STROTHER FIELD
Walter
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

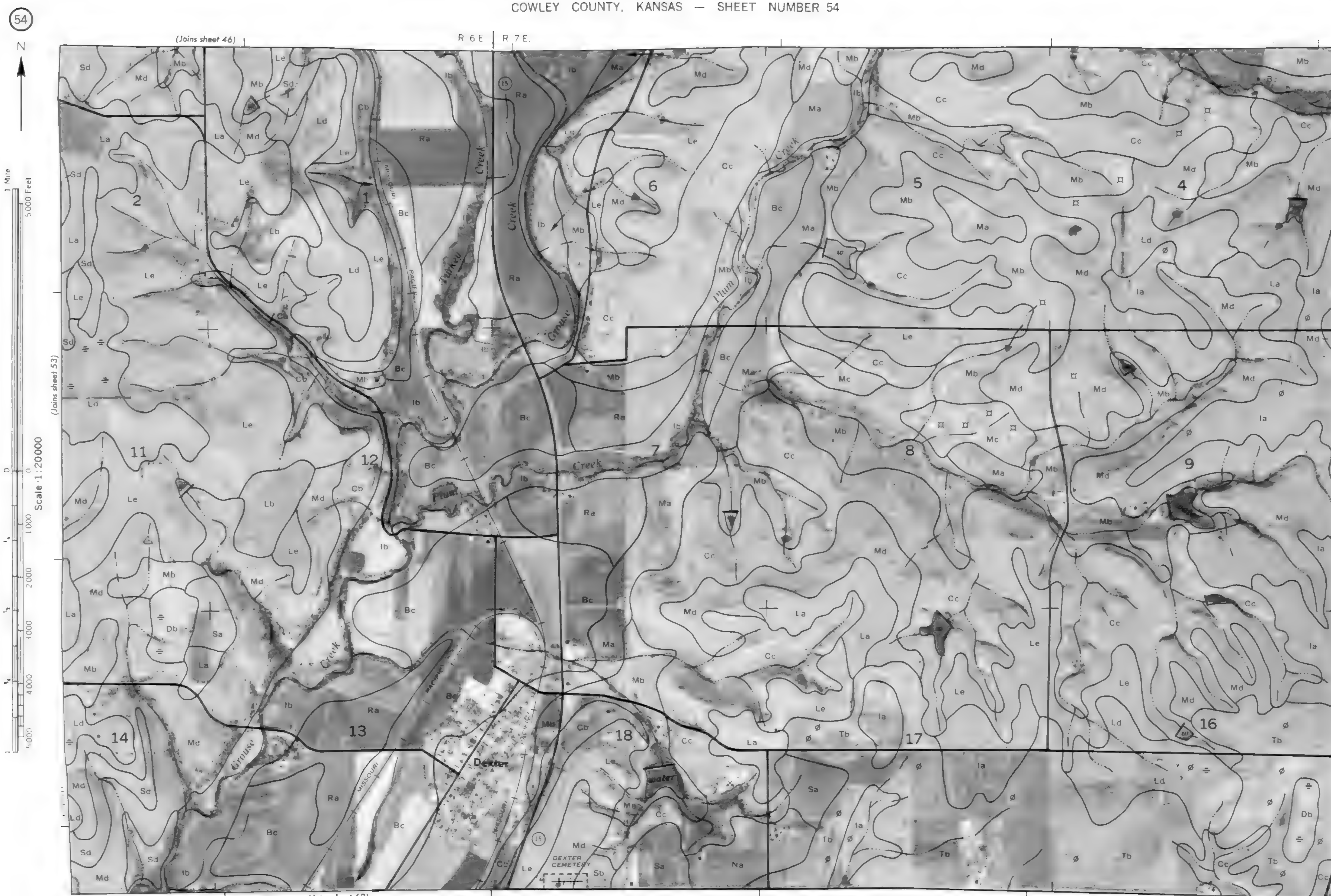

N
R 4 E | R 5 E
(Joins sheet 43)
(Joins sheet 52)
(Joins sheet 59)
(Joins sheet 50)
T 33 S
WALNUT RIVER
WALNUT RIVER
West Badger
East Badger
Badger Creek
Big Badger
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

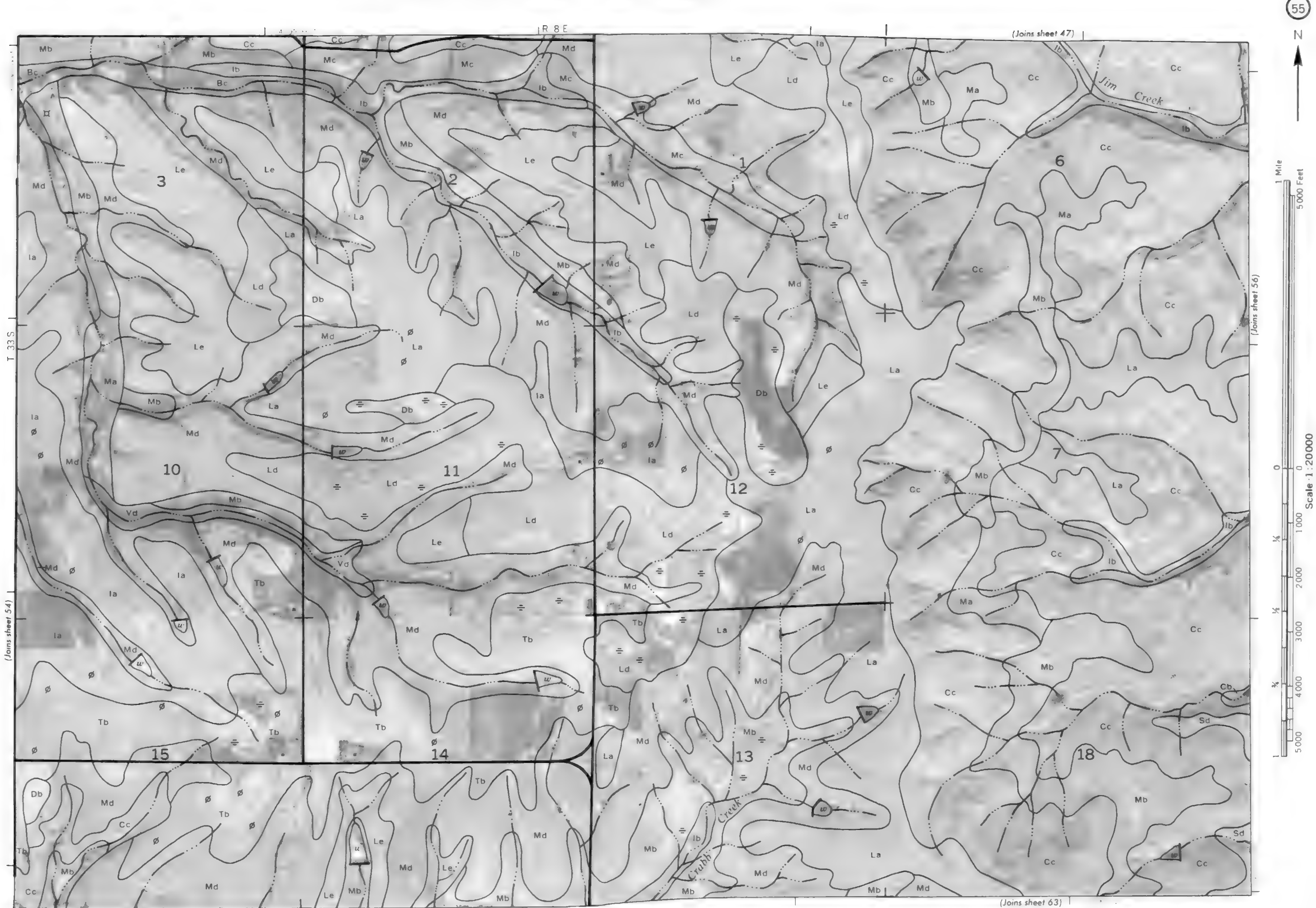
52

COWLEY COUNTY, KANSAS — SHEET NUMBER 52

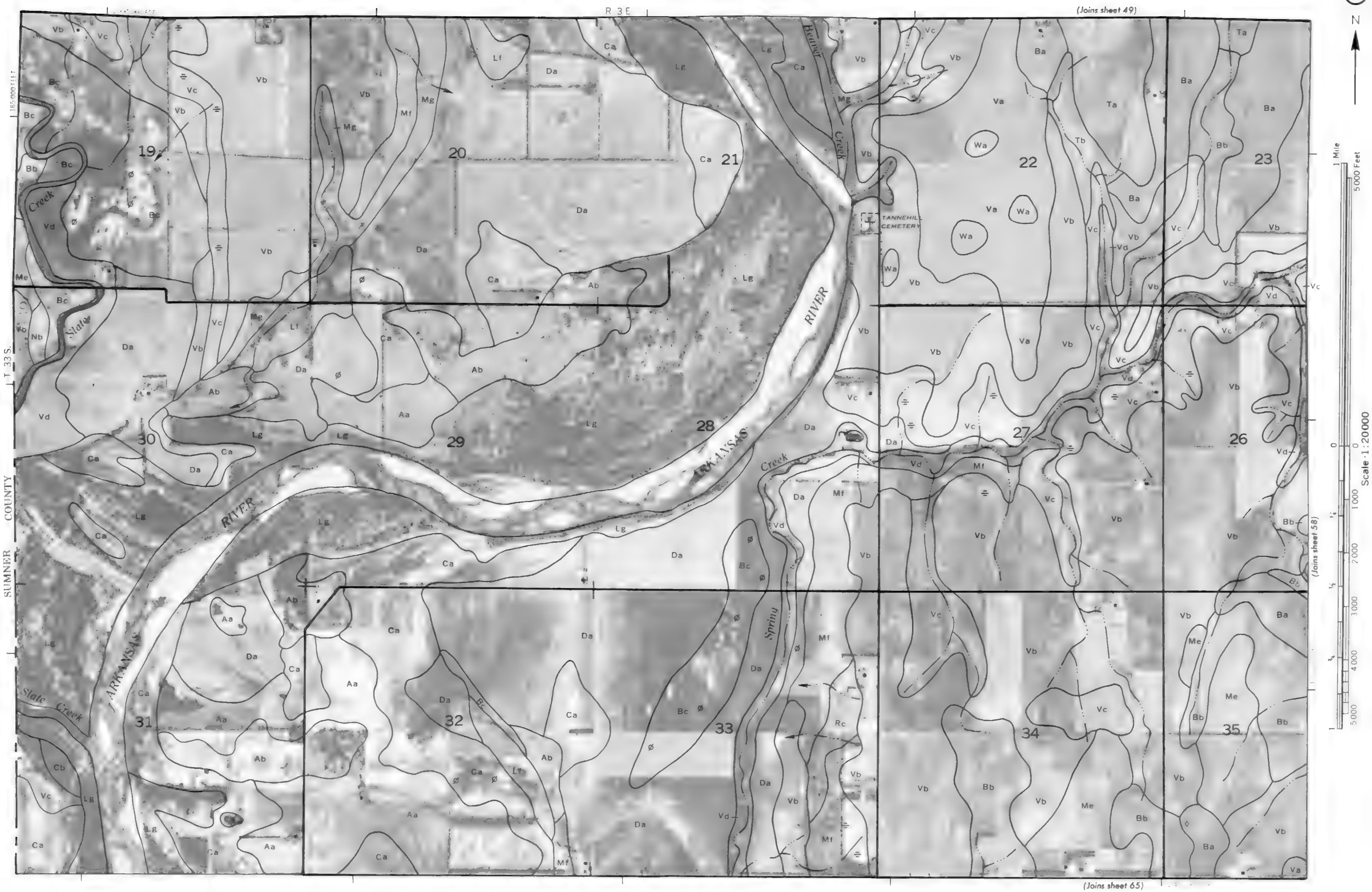


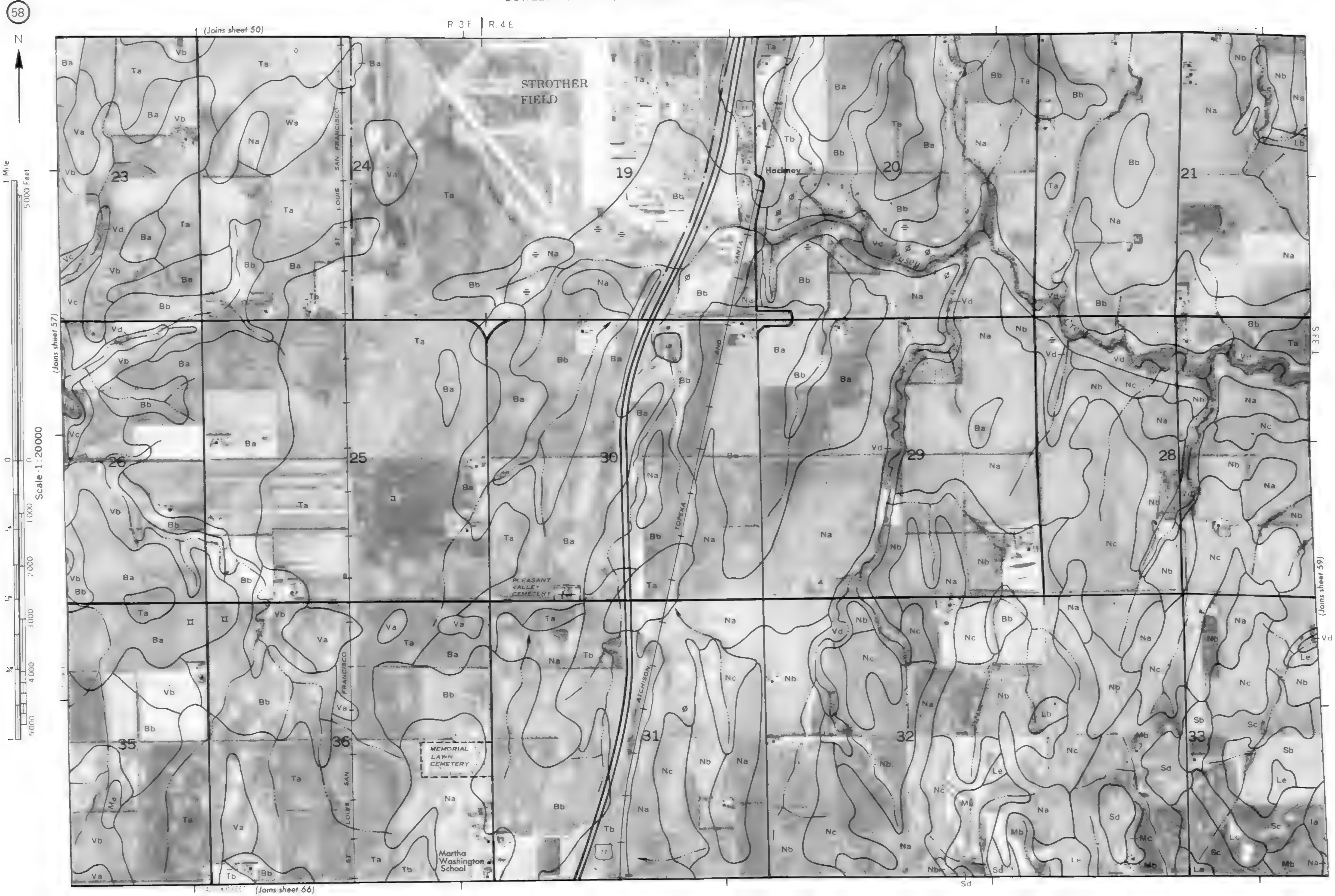

R 6 E
(Joins sheet 45)
(Joins sheet 54)
(Joins sheet 61)
(Joins sheet 52)
T 33 S
Pebble Creek
Harper Creek
RIDGE CEMETERY
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
N
1 Mile
5000 Feet
Scale 1:20000

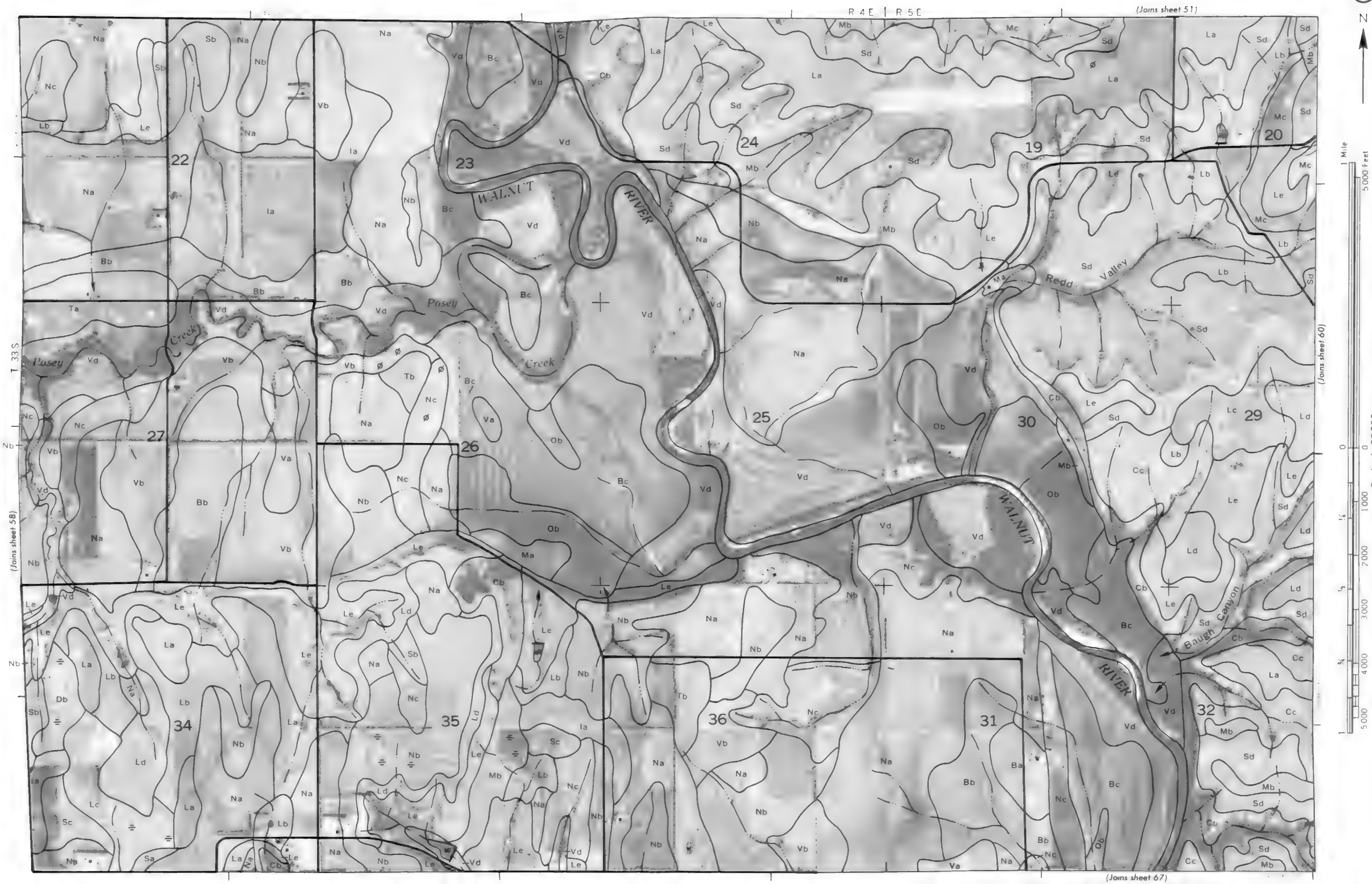

54
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 46)
R 6 E
R 7 E
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 62)
T 33 S
Turkey Creek
Grouse Creek
Plum Creek
Creek
MISSOURI PACIFIC
Dexter
DEXTER CEMETERY
water
15


55
N
R 8 E
T 33 S
(Joins sheet 47)
(Joins sheet 56)
(Joins sheet 54)
(Joins sheet 63)
Jim Creek
Crabb Creek
1 Mile
5000 Feet
Scale 1:20000

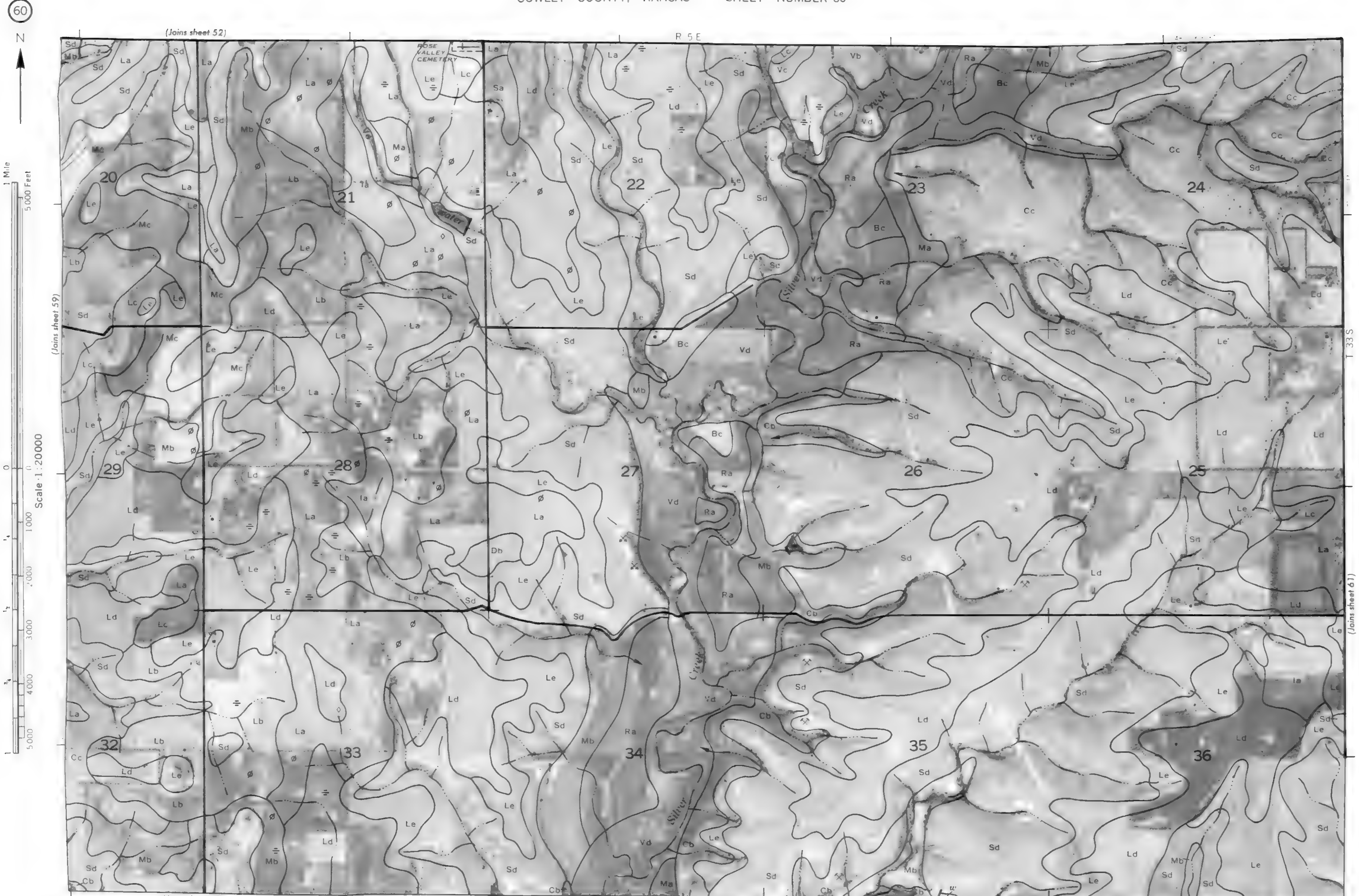
This map is compiled on 197[illegible] aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


(Joins sheet 49)
R 3 E
T 33 S.
N
SUMNER COUNTY
(Joins sheet 58)
(Joins sheet 65)
ARKANSAS RIVER
Slate Creek
Beaver Creek
Spring Creek
TANNEHILL CEMETERY
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


58
N
(Joins sheet 50)
R 3 E
R. 4 E
STROTHER FIELD
Hackney
SAN FRANCISCO
ST LOUIS
SANTA FE
AND
TOPEKA
ATCHISON
PLEASANT VALLEY CEMETERY
MEMORIAL LAWN CEMETERY
Martha Washington School
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 66)
T 33 S
Scale 1:20000
1 Mile
5000 Feet
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

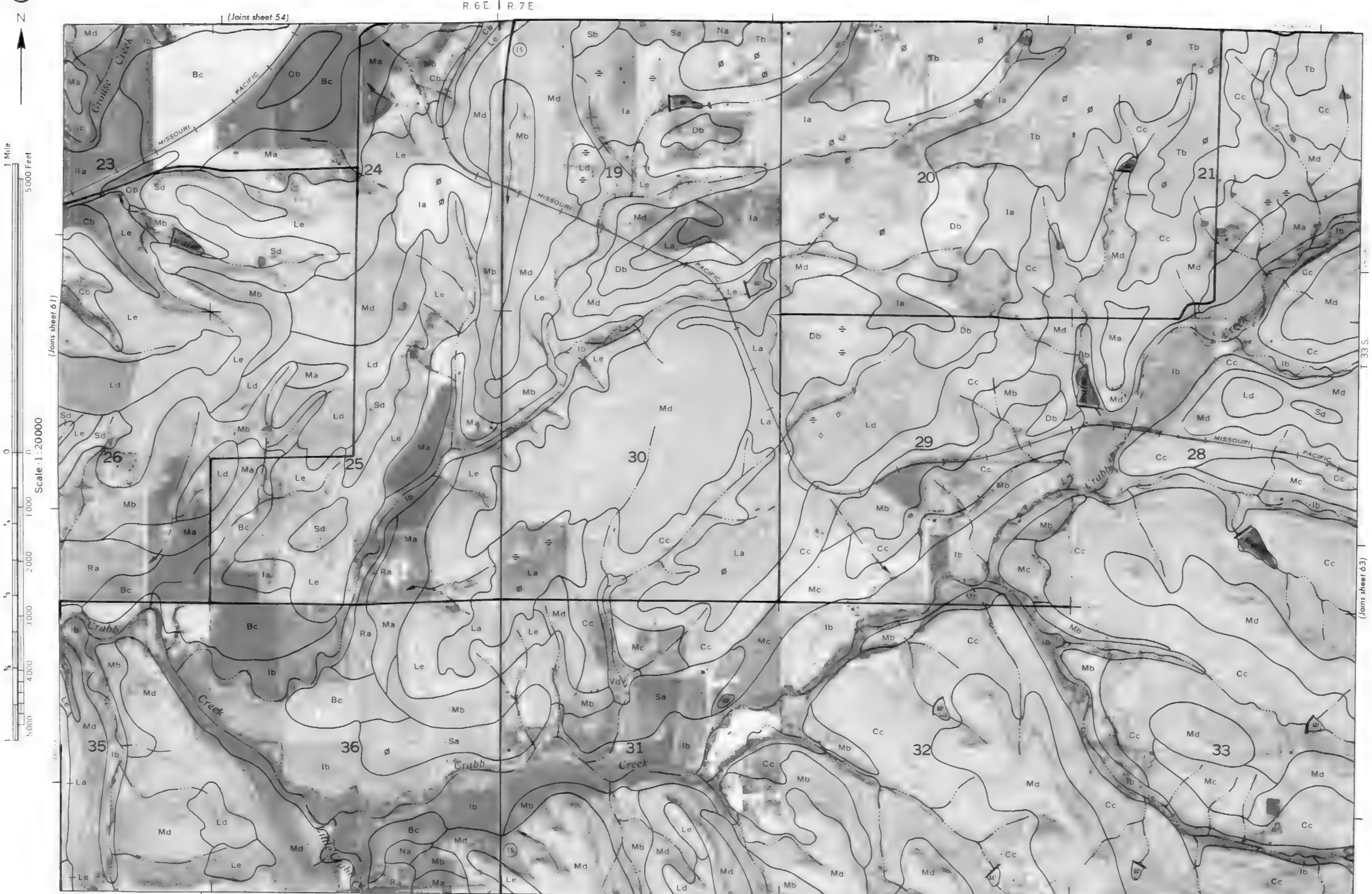


(Joins sheet 51)
R 4 E | R 5 E
N
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 67)
T. 33 S.
WALNUT RIVER
Posey Creek
Redd Valley
Baugh Canyon
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
1 Mile
5000 Feet
Scale 1:20000

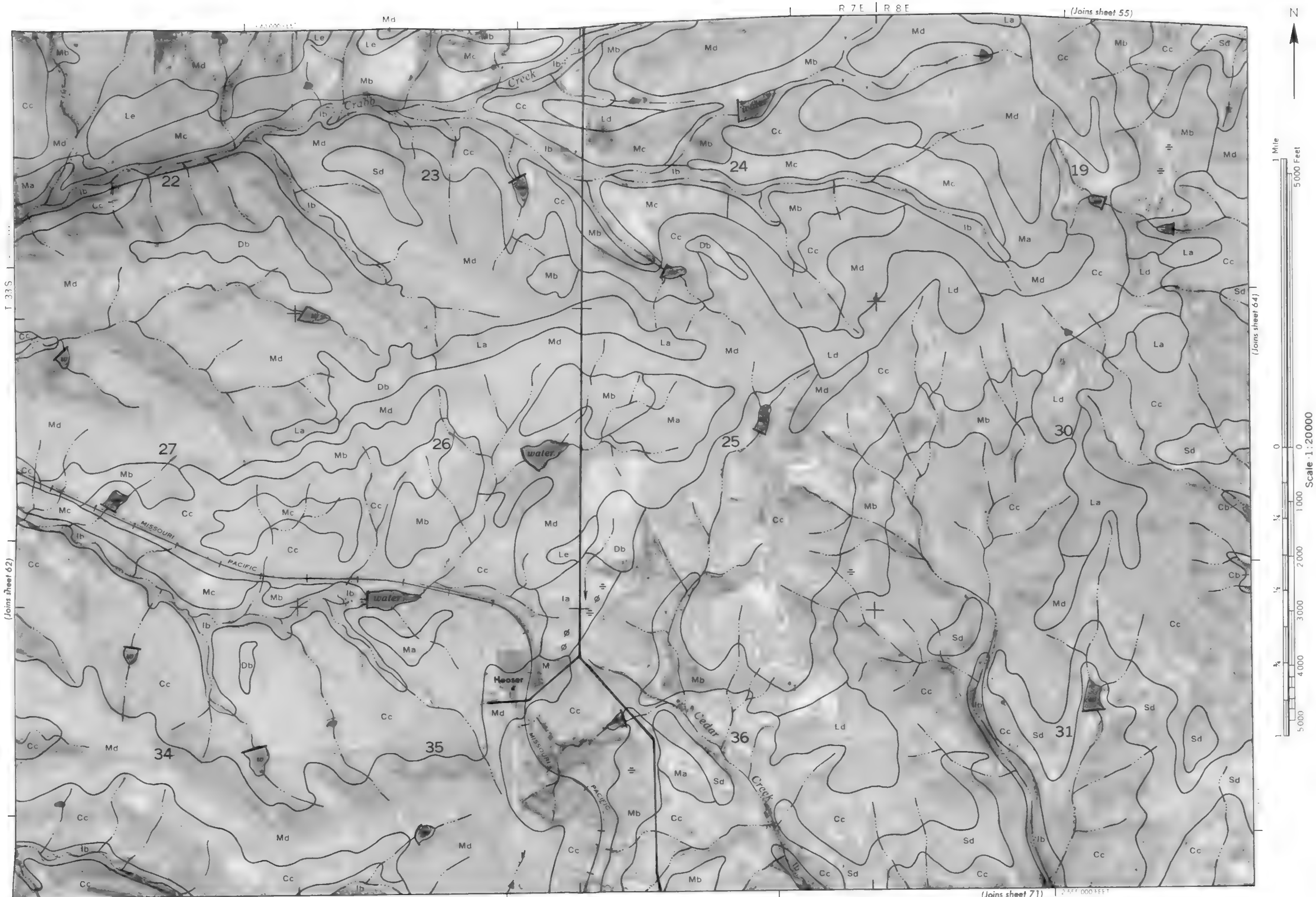

60
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 52)
R 5 E
ROSE VALLEY CEMETERY
Water
Silver Creek
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 68)
T 33 S
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


61
(Joins sheet 53)
R 6 E
T 33 S
(Joins sheet 60)
(Joins sheet 62)
(Joins sheet 69)
N
1 Mile
5000 Feet
Scale 1:20000
Horse Creek
Grouse Creek
Crabb Creek
Wildcat Cr
MISSOURI PACIFIC
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

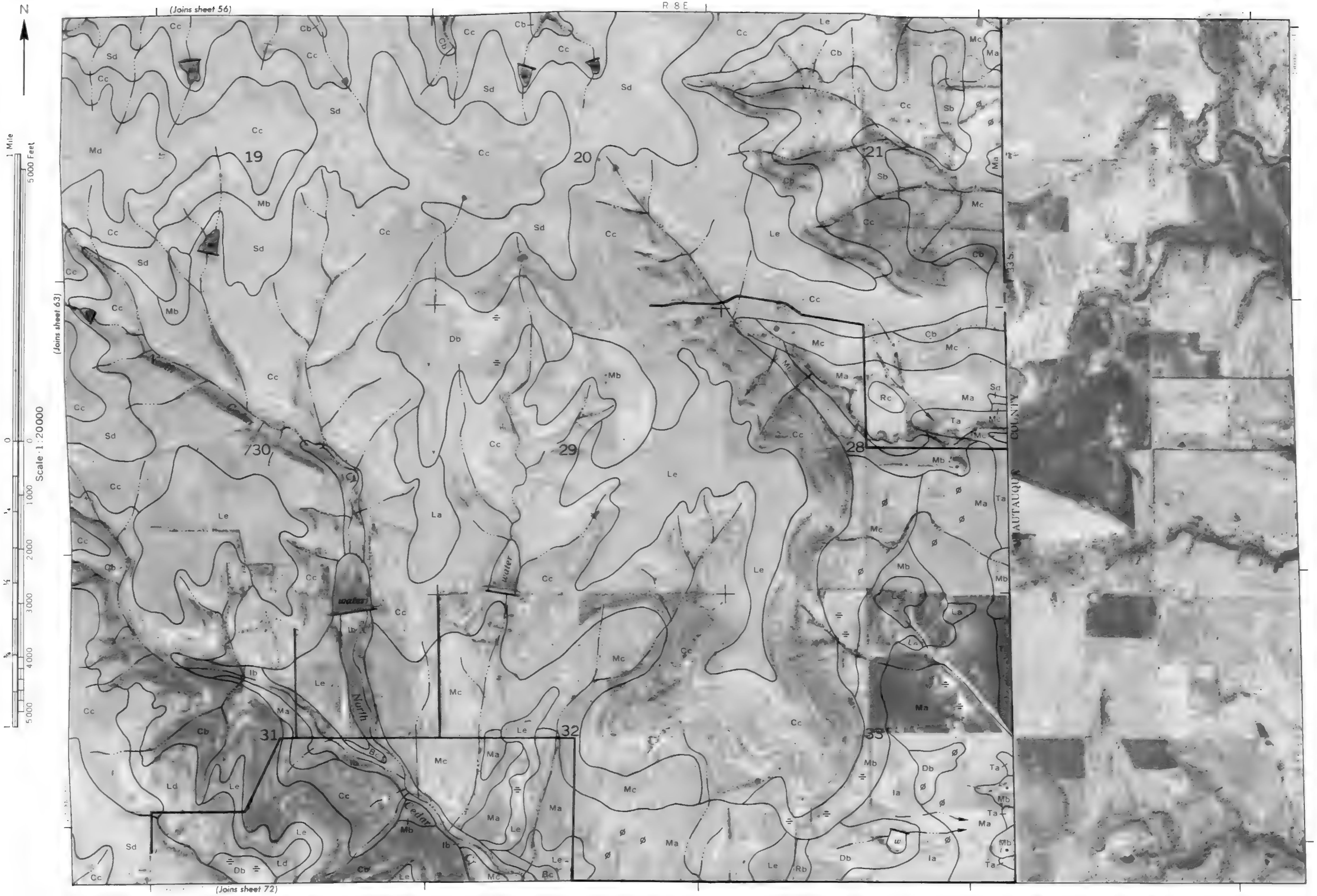
COWLEY COUNTY, KANSAS — SHEET NUMBER 62



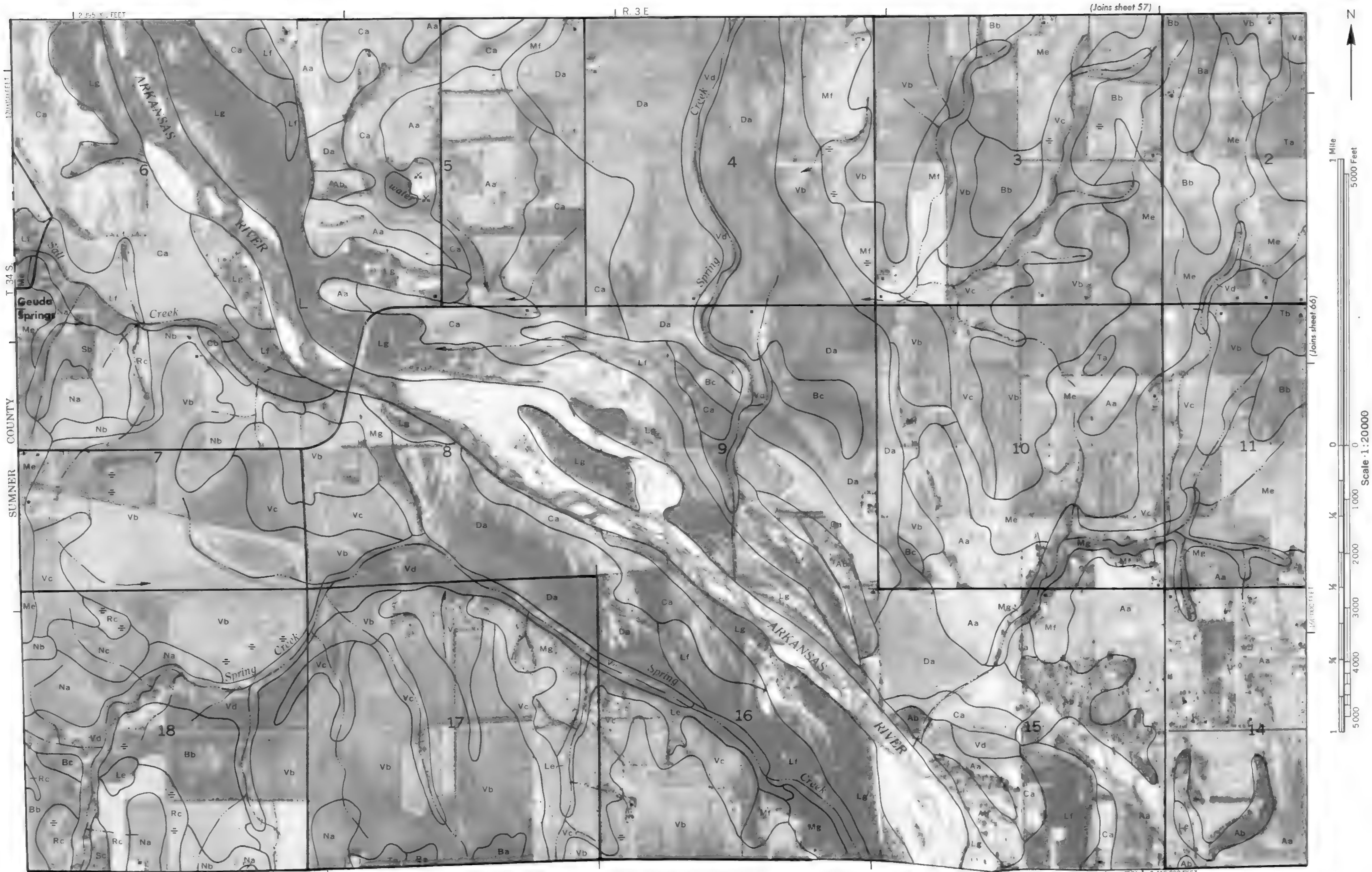
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


R 7 E
R 8 E
(Joins sheet 55)
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 71)
T 33 S
N
Crabb
Creek
Cedar
Creek
MISSOURI
PACIFIC
Heaser
water
22
23
24
19
27
26
25
30
34
35
36
31
Md
Mb
Mc
Ma
Le
Cc
Ib
Db
La
Ld
Sd
Cb
Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

COWLEY COUNTY, KANSAS — SHEET NUMBER 64



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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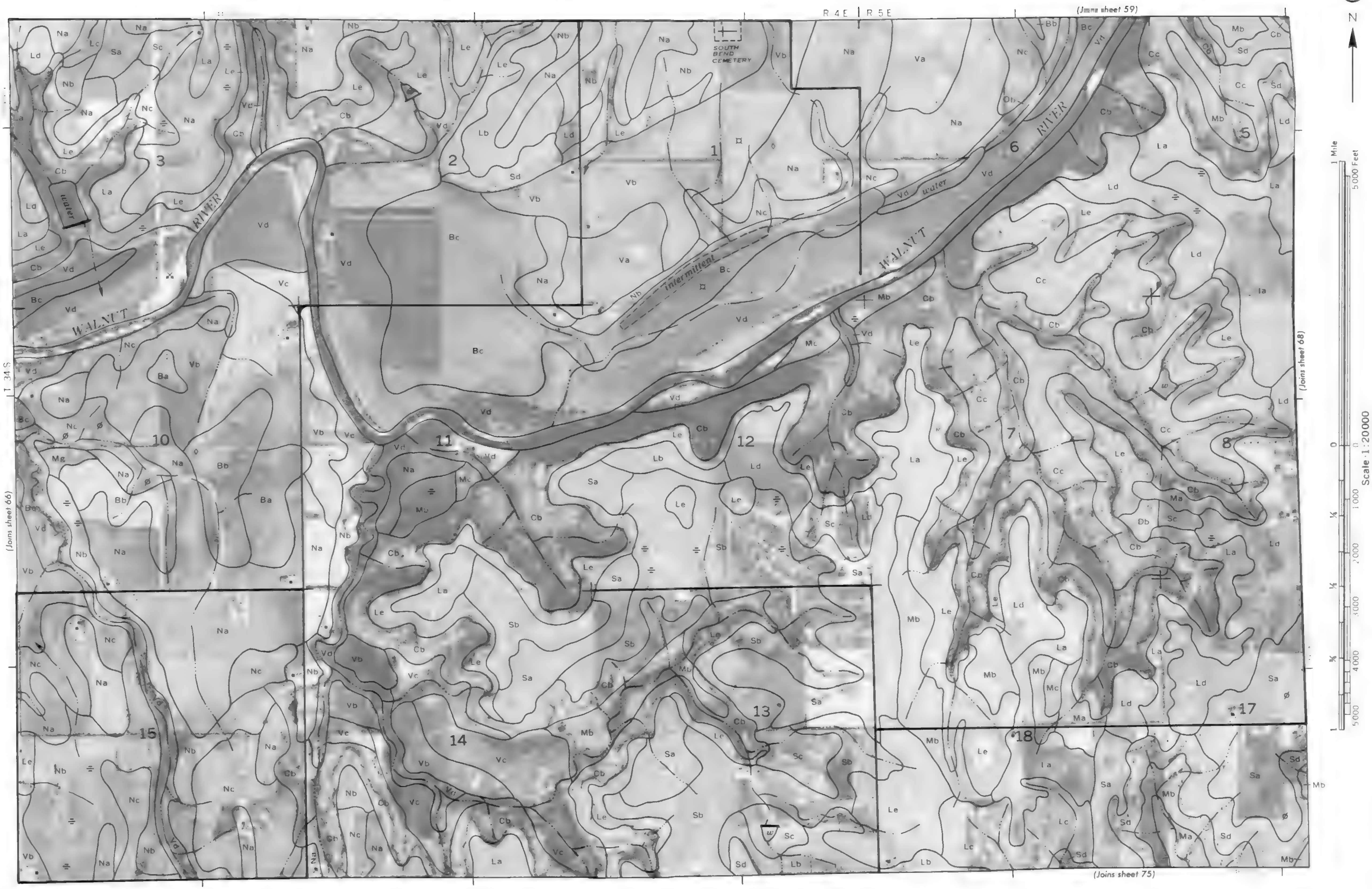
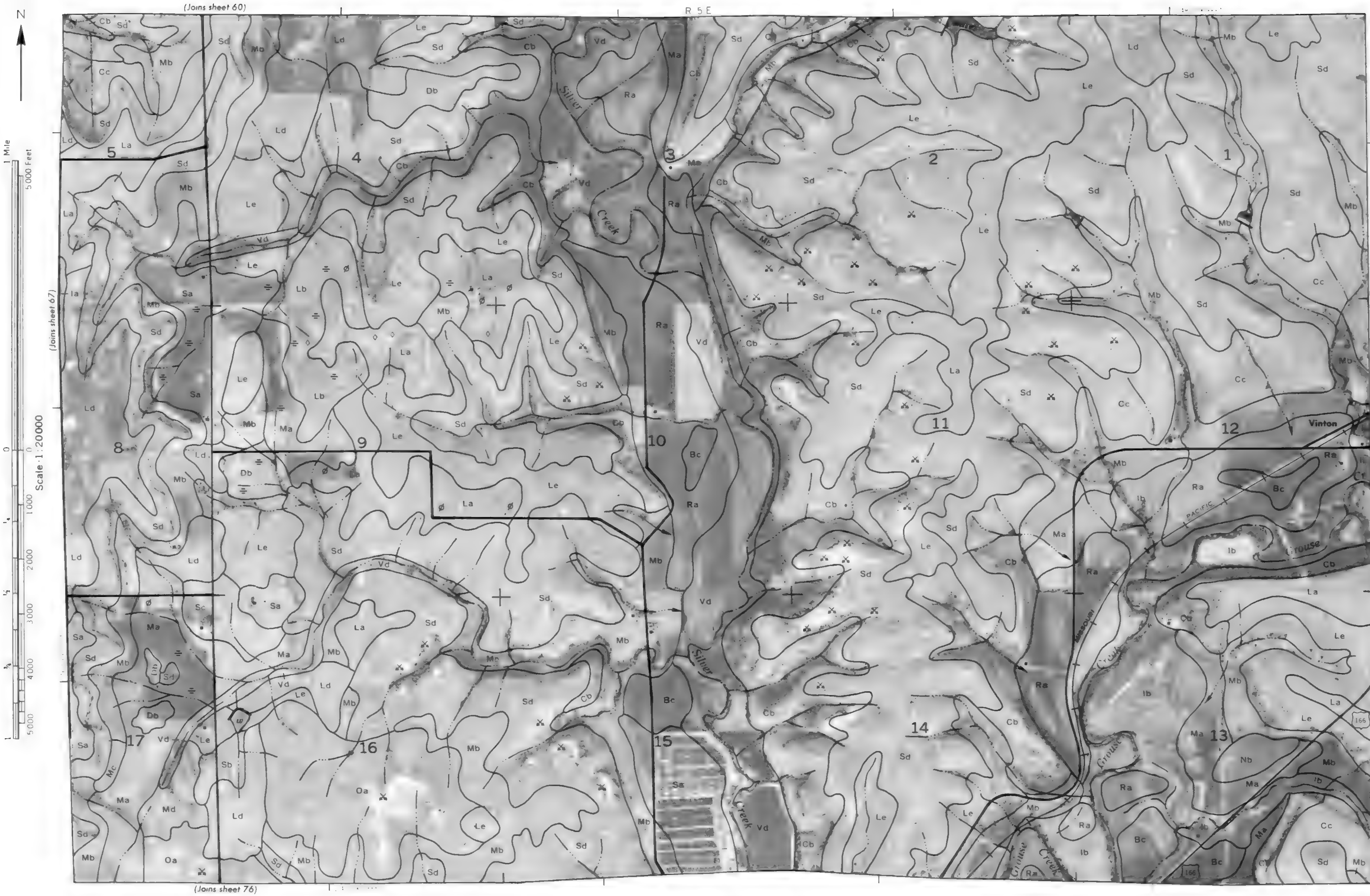
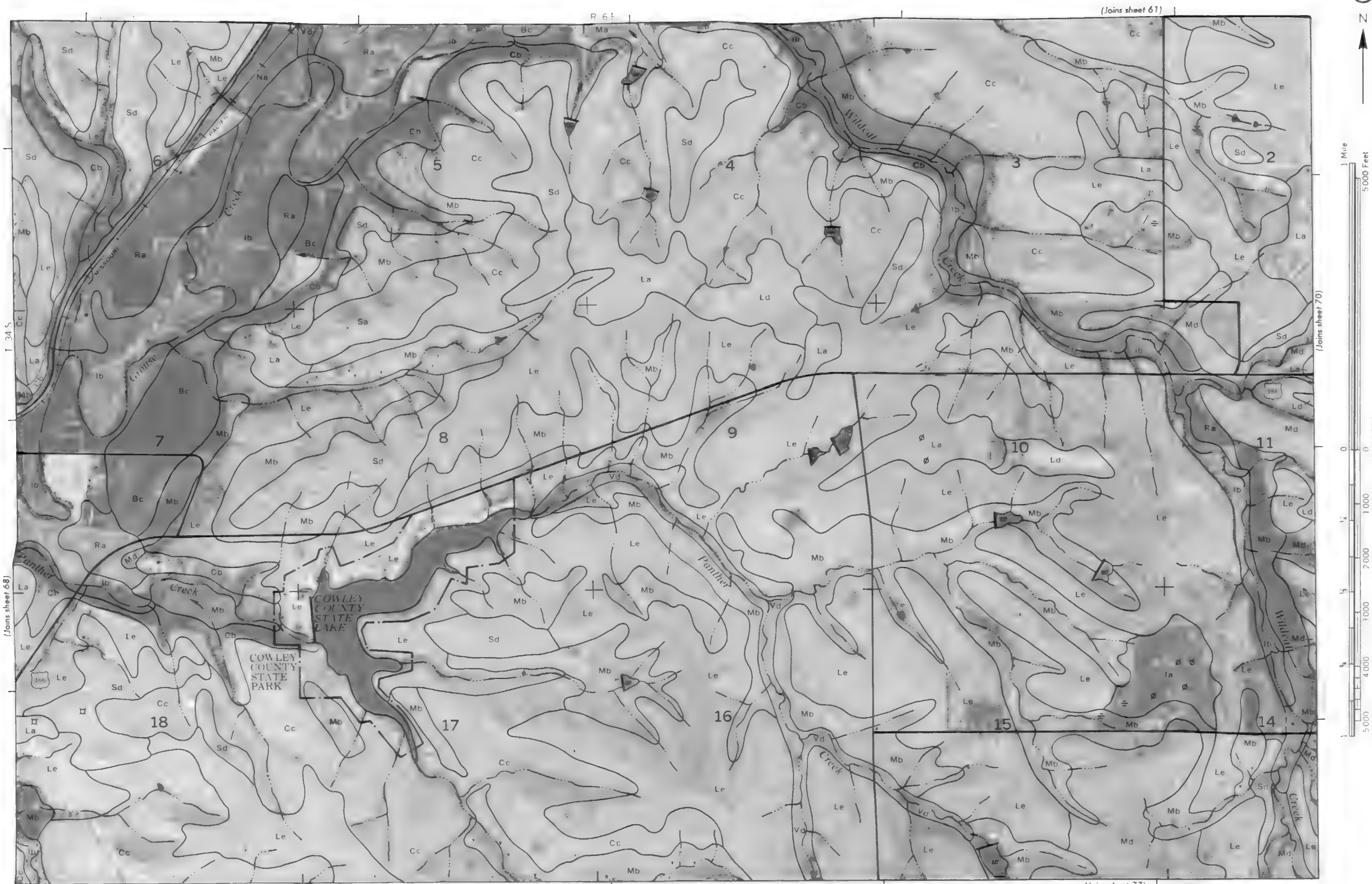
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

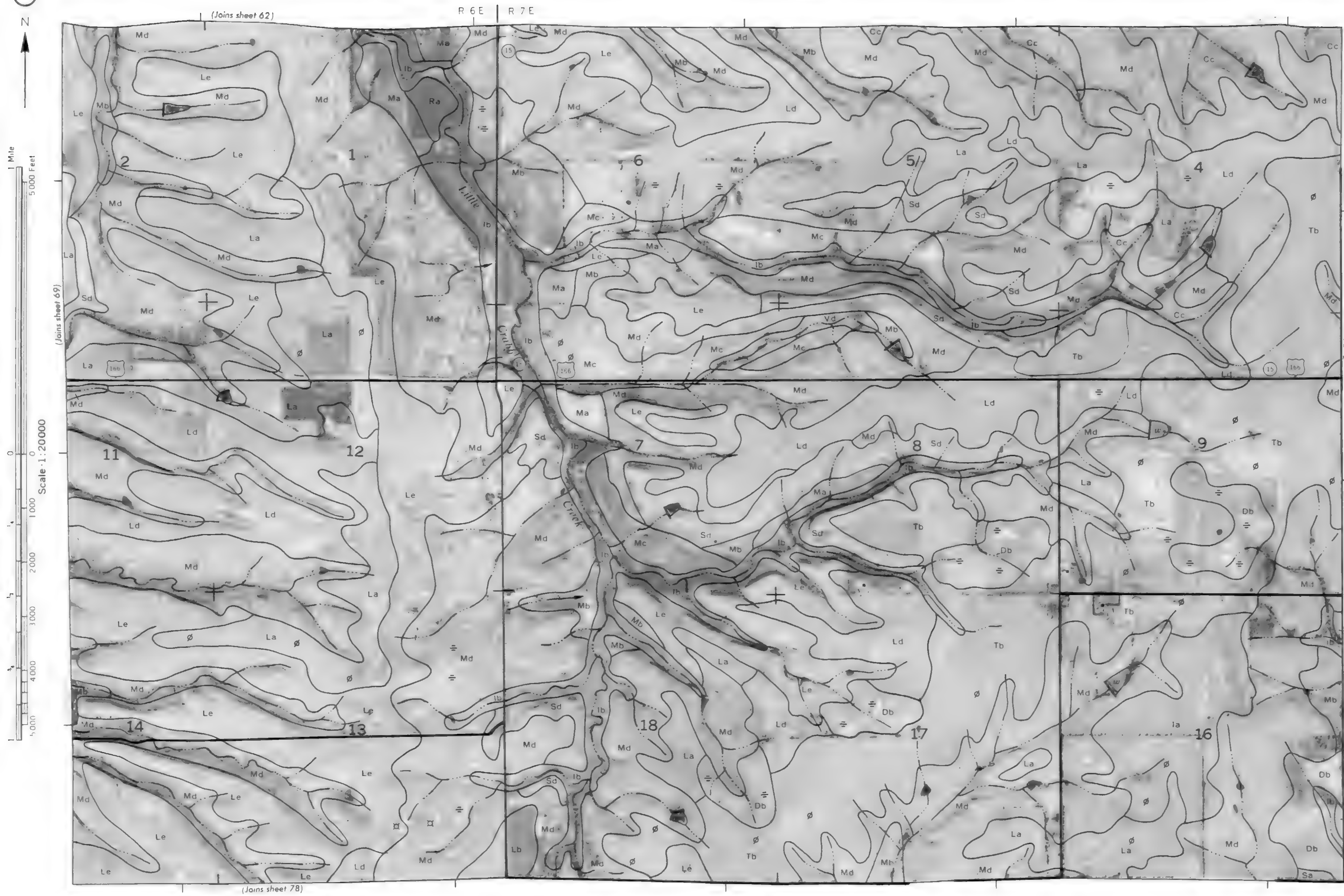
COWLEY COUNTY, KANSAS — SHEET NUMBER 66

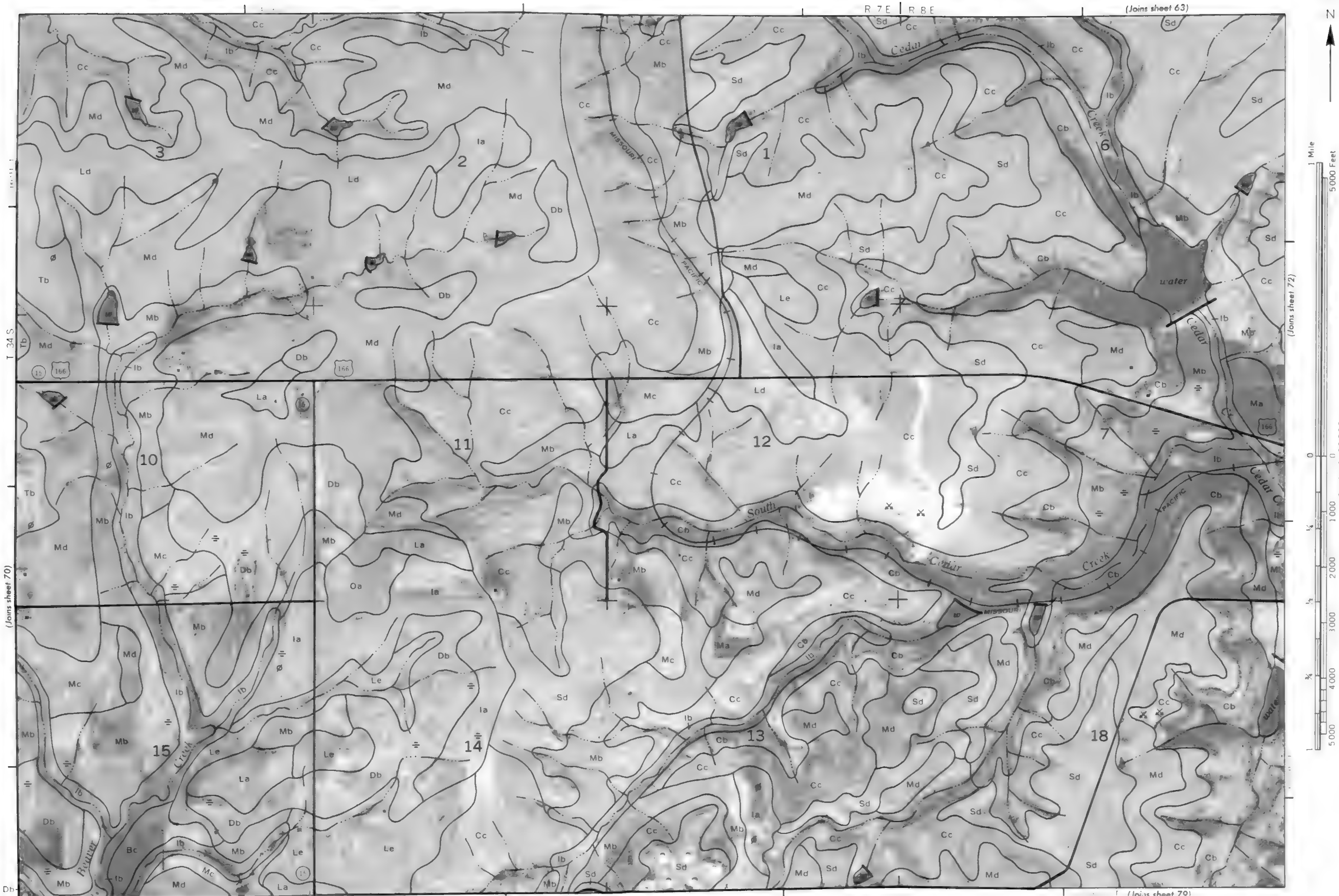

(Joins sheet 59)
(Joins sheet 68)
(Joins sheet 75)
(Joins sheet 66)
R 4 E
R 5 E
T 34 S
SOUTH BEND CEMETERY
WALNUT RIVER
water
intermittent
N
Scale 1:20000
1 Mile
5000 Feet


N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 60)
R 5 E
T 34 S.
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 76)
Silver Creek
Silver Creek
Grouse Creek
Grouse
Vinton
PACIFIC
166

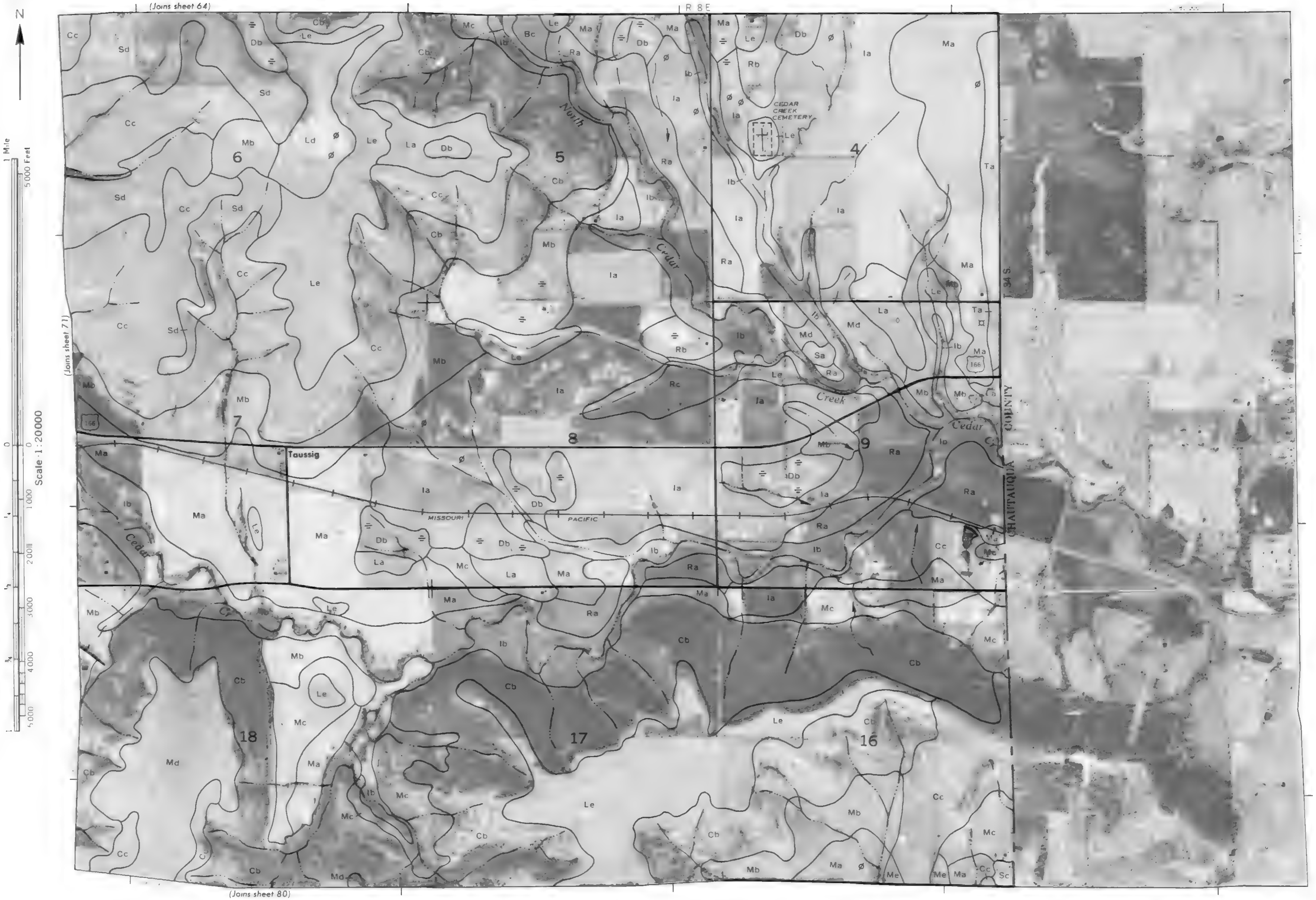


(Joins sheet 61)
(Joins sheet 70)
(Joins sheet 77)
(Joins sheet 68)
R 6 E
T 34 S
N
Scale 1:20000
1 Mile
5000 Feet
COWLEY COUNTY STATE LAKE
COWLEY COUNTY STATE PARK
Grouse Creek
Panther Creek
Wildcat Creek
Missouri

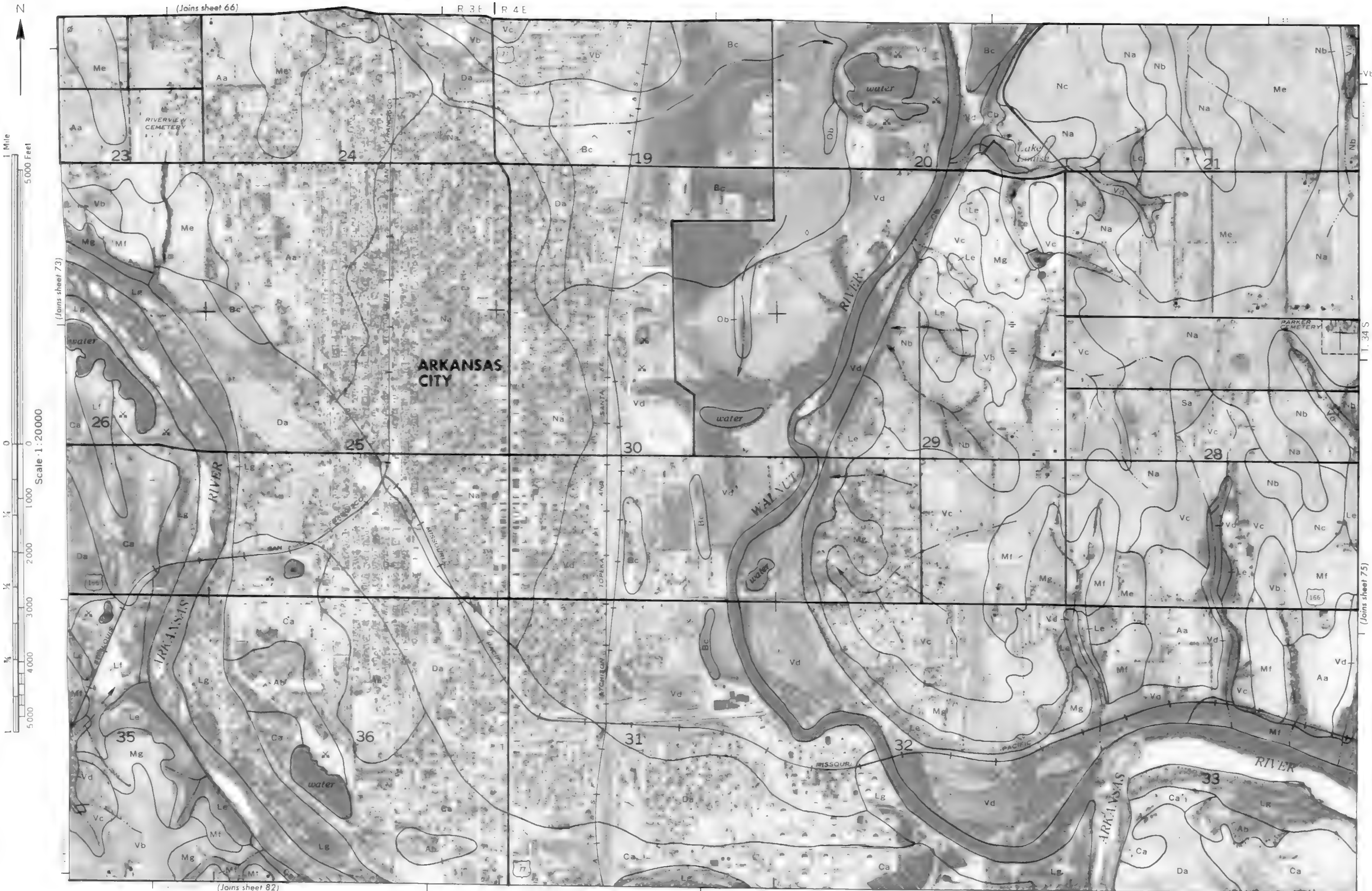

N
(Joins sheet 62)
R 6 E
R 7 E
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 78)
T. 34 S.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
Little
Crab
Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18
15
166
Md
Le
La
Ld
Mb
Ma
Mc
Ra
Ib
Sd
Cc
Tb
Db
Vd
Lb
Sa

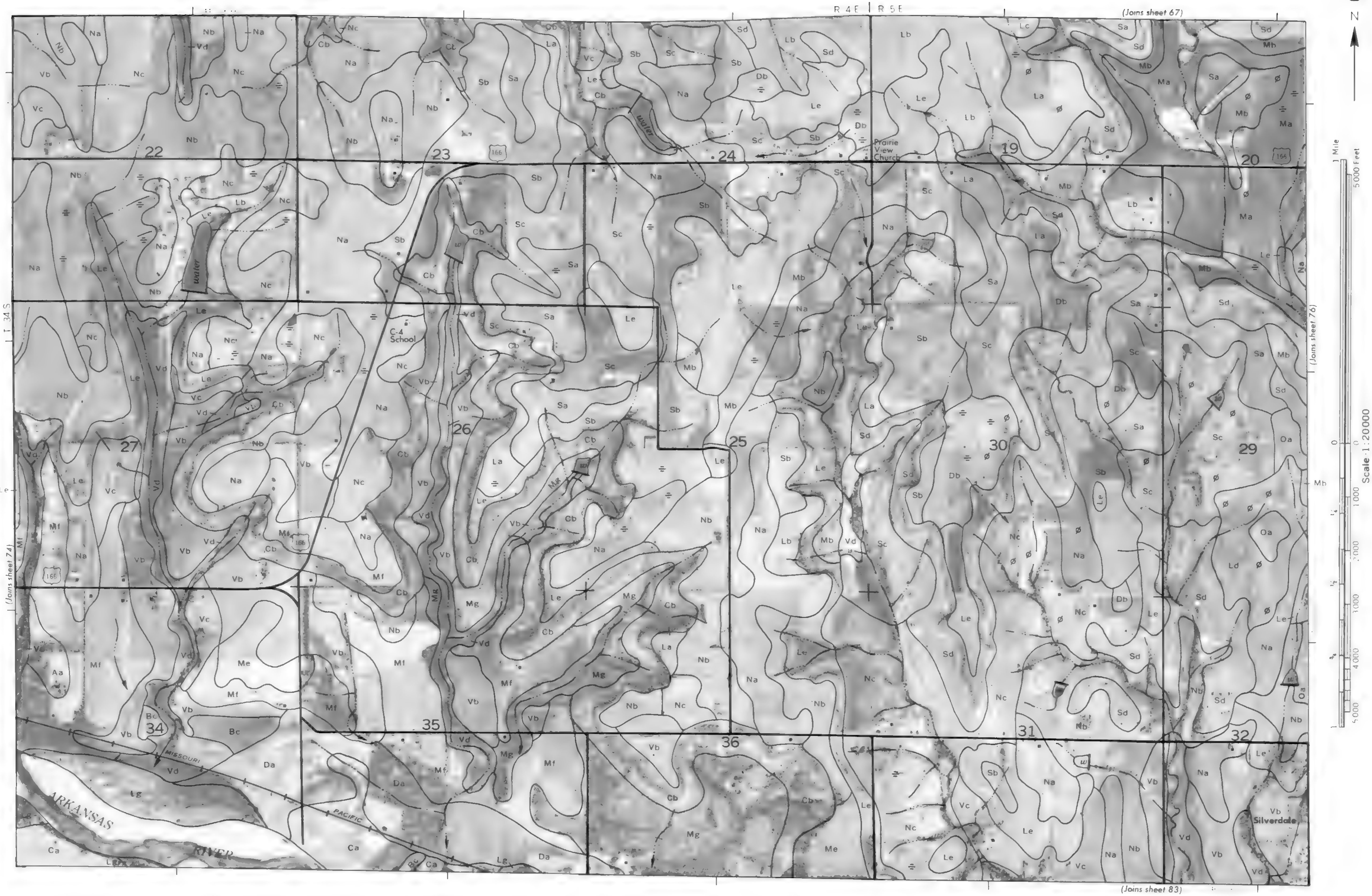

(Joins sheet 63)
(Joins sheet 72)
(Joins sheet 70)
(Joins sheet 79)
R 7 E
R 8 E
T 34 S
N
1 Mile
5000 Feet
Scale 1:20000
Cedar Creek
South Cedar Creek
Cedar Creek
Beaver Creek
MISSOURI PACIFIC
water
1
2
3
6
7
10
11
12
13
14
15
18

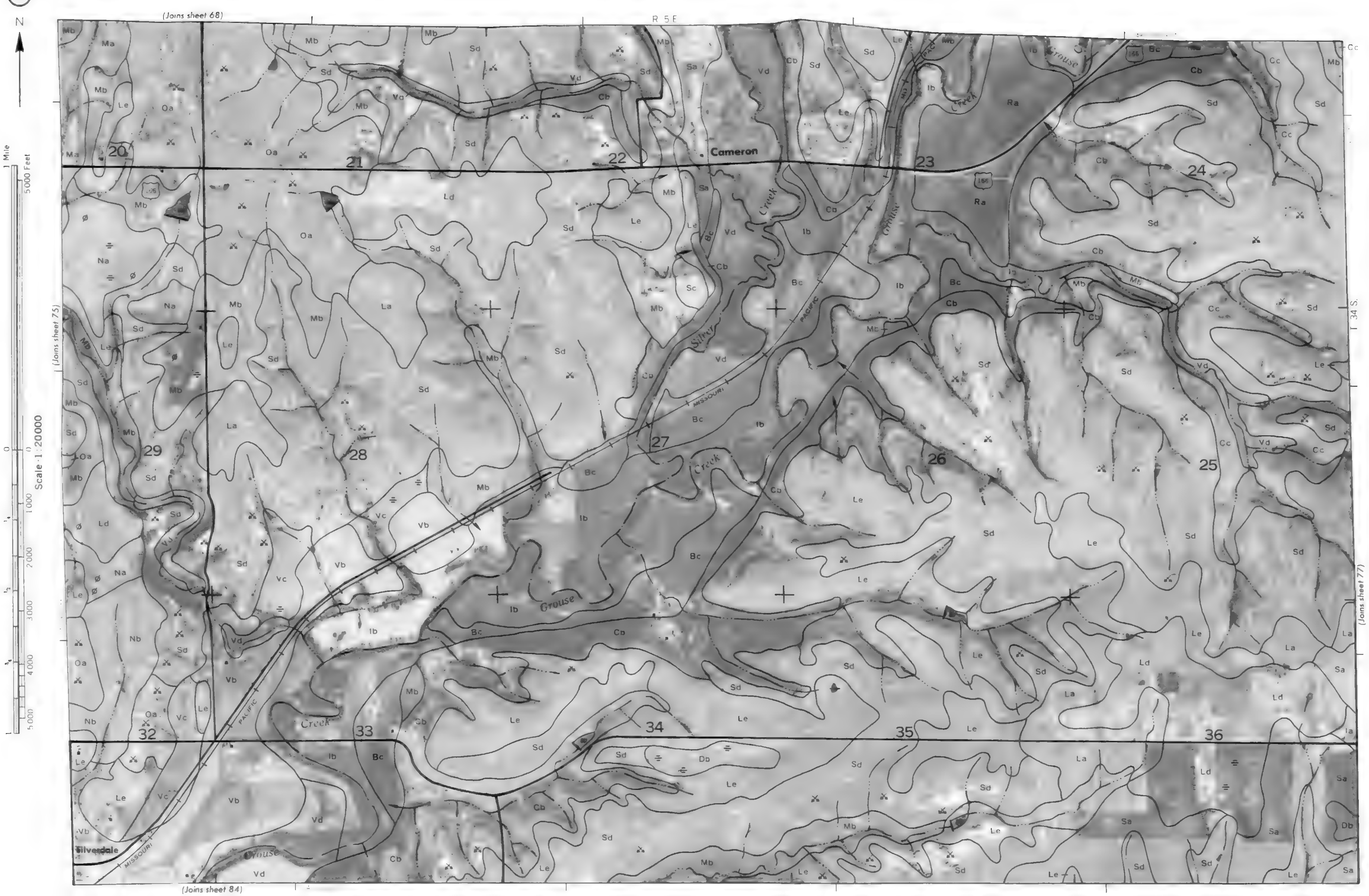
(72)

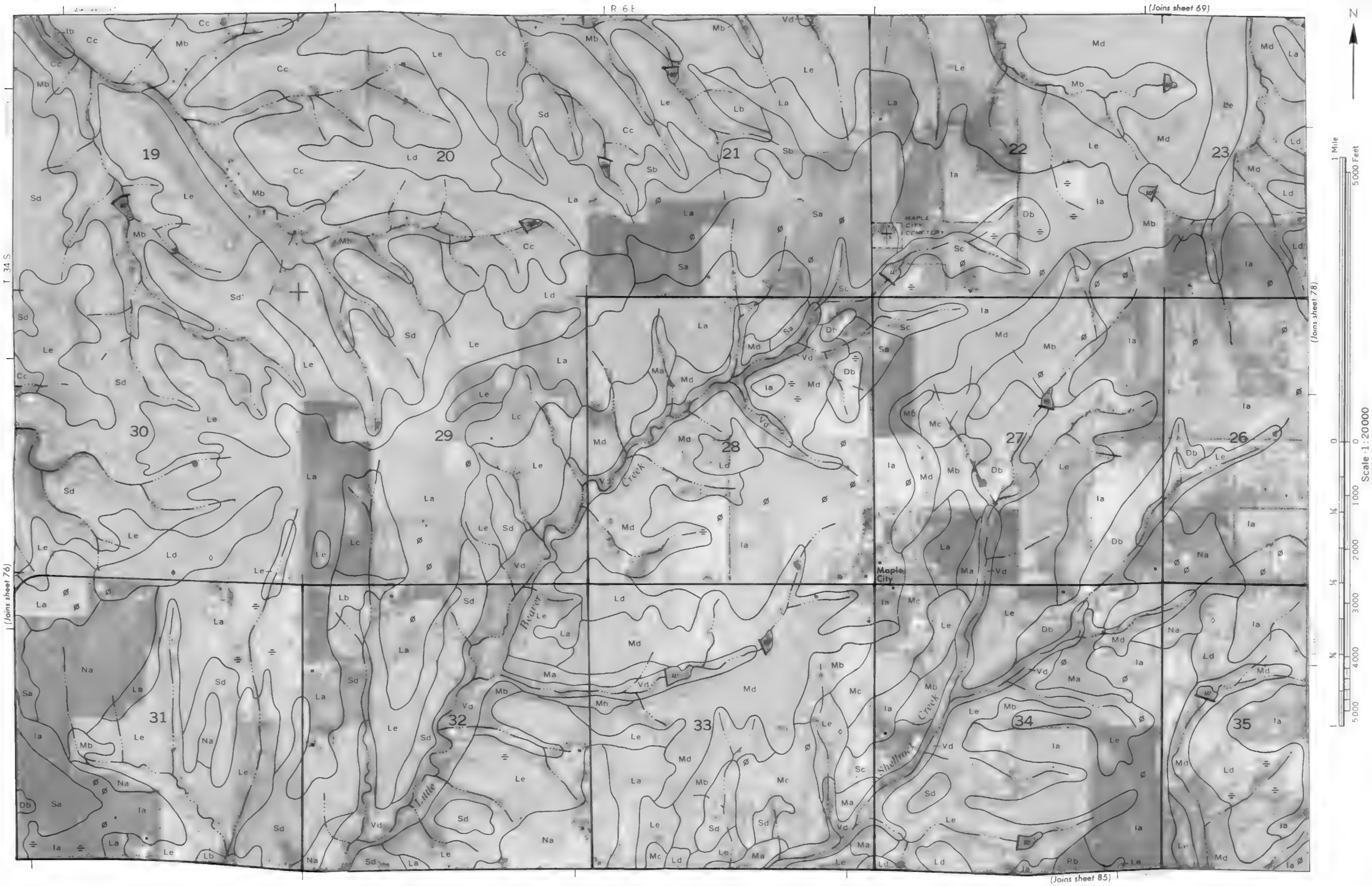

N
Scale 1:20000
1 Mile
5000 Feet
(Joins sheet 64)
(Joins sheet 71)
(Joins sheet 80)
R 8 E
34 S.
CEDAR CREEK CEMETERY
North Cedar
Cedar Creek
Cedar
Taussig
MISSOURI PACIFIC
CHAUTAUQUA COUNTY
166


R 3 E
T 34 S
SUMNER COUNTY
(Joins sheet 65)
(Joins sheet 74)
(Joins sheet 81)
ARKANSAS RIVER
Spring Creek
Negro Creek
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
166
N
1 Mile
5000 Feet
Scale 1:20000


74
N
(Joins sheet 66)
R 3 E
R 4 E
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 82)
T. 34 S.
1 Mile
5000 Feet
Scale 1:20000
ARKANSAS CITY
RIVERVIEW CEMETERY
PARKER CEMETERY
Lake Louise
WALNUT RIVER
ARKANSAS RIVER
water
SANTA FE
ATCHISON TOPEKA AND SANTA FE
MISSOURI PACIFIC
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33


75
N
R 4 E | R 5 E
(Joins sheet 67)
(Joins sheet 76)
(Joins sheet 74)
(Joins sheet 83)
T 34 S
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Prairie View Church
C-4 School
water
166
MISSOURI PACIFIC
ARKANSAS RIVER
Silverdale
1 Mile
5000 Feet
Scale 1:20000


76
N
(Joins sheet 68)
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 84)
R 5 E
T 34 S.
1 Mile
5000 Feet
Scale 1:20000
Cameron
Silverdale
Silver Creek
Grouse Creek
MISSOURI PACIFIC
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36



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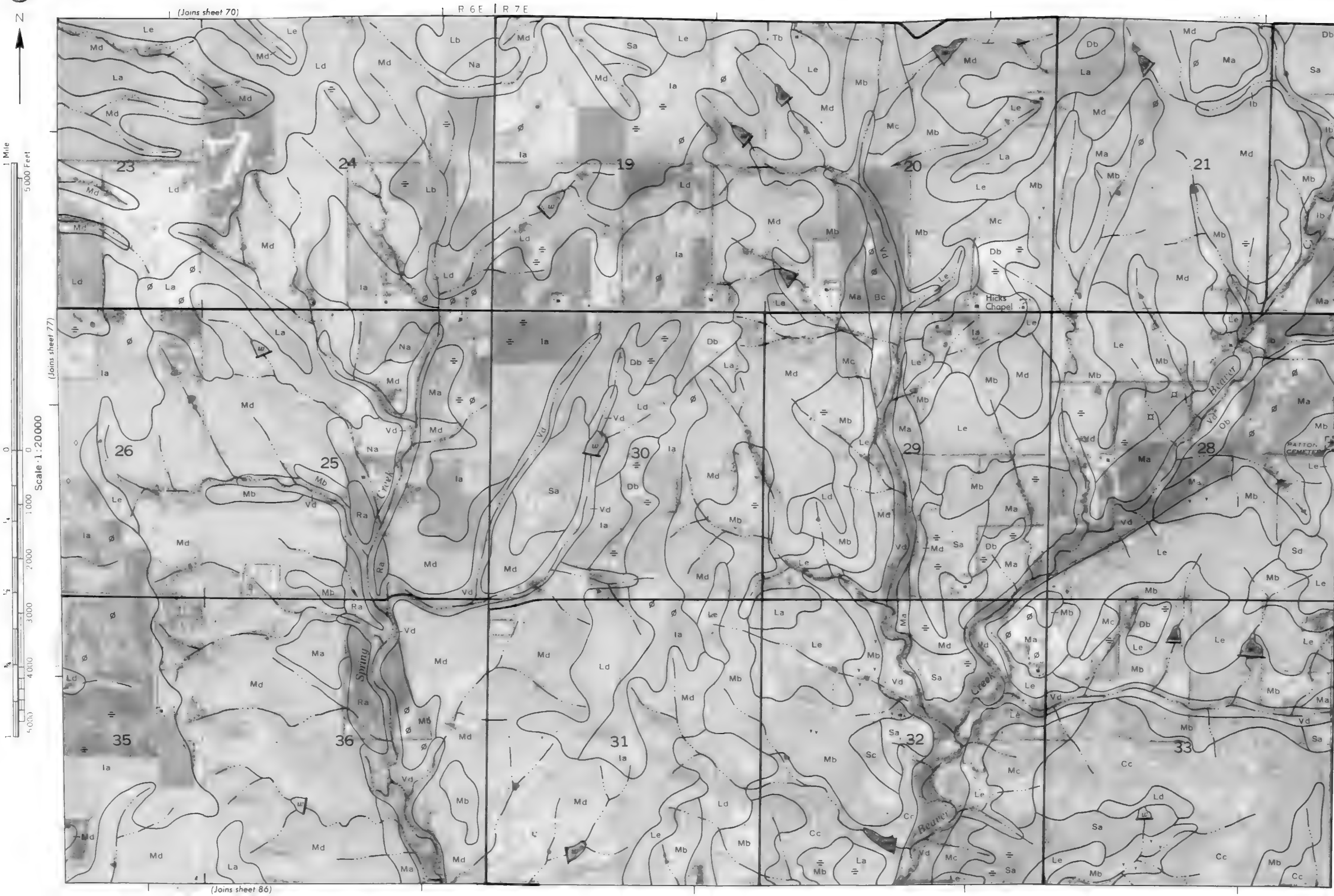
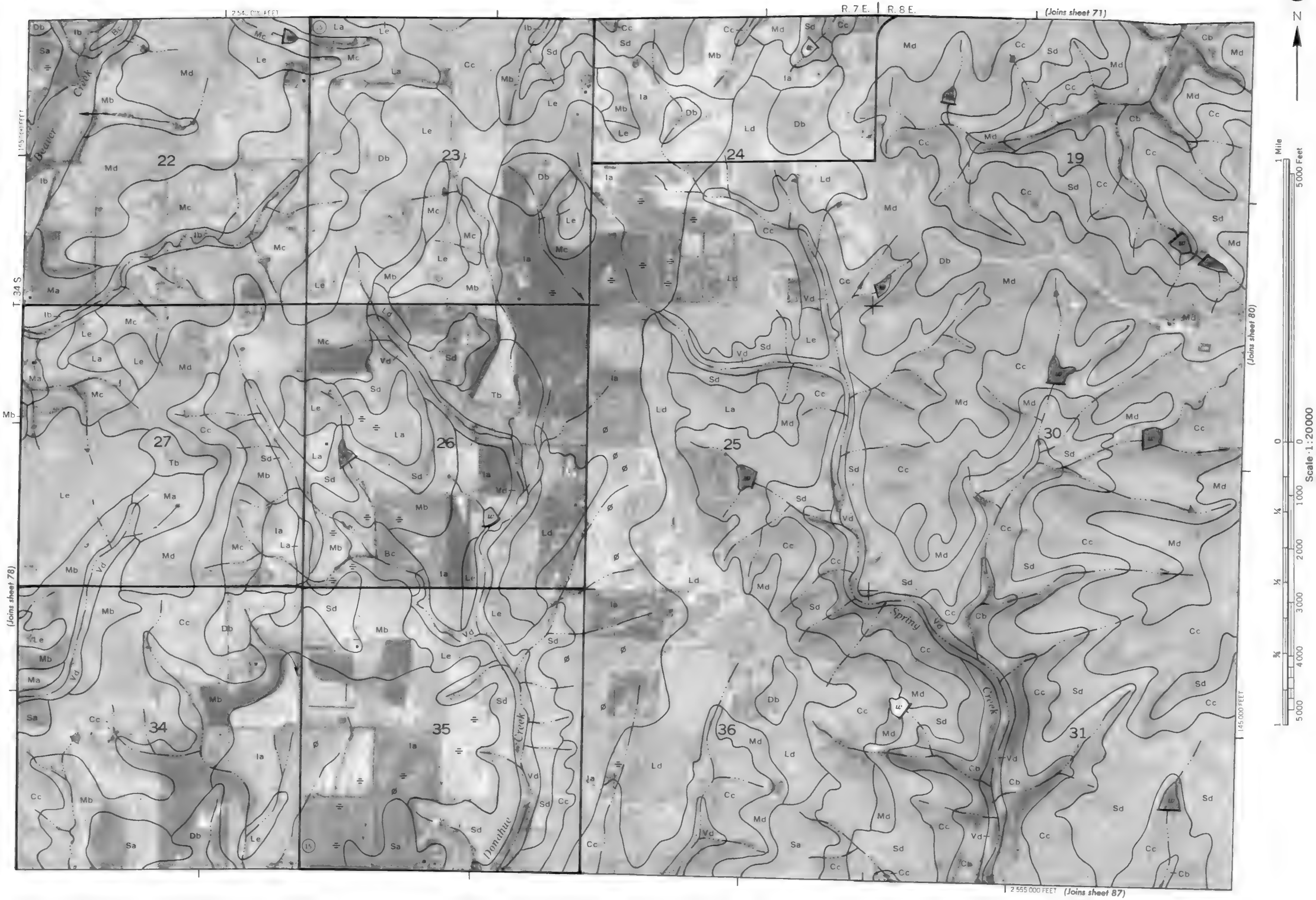

N
(Joins sheet 70)
R 6 E
R 7 E
(Joins sheet 77)
(Joins sheet 79)
(Joins sheet 86)
T 34 S.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
Hicks Chapel
Patton Cemetery
Spring Creek
Beaver Creek
Beaver



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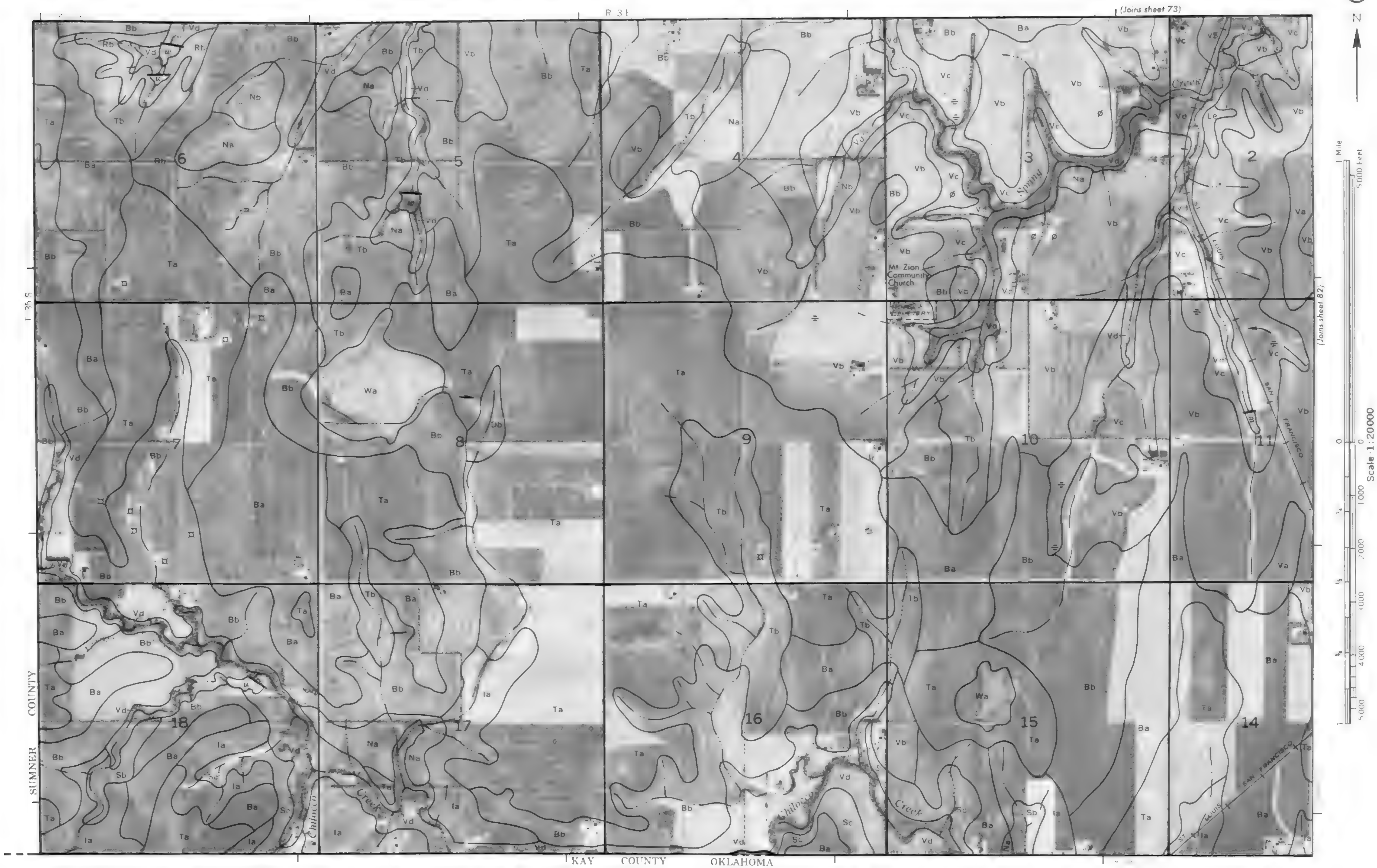
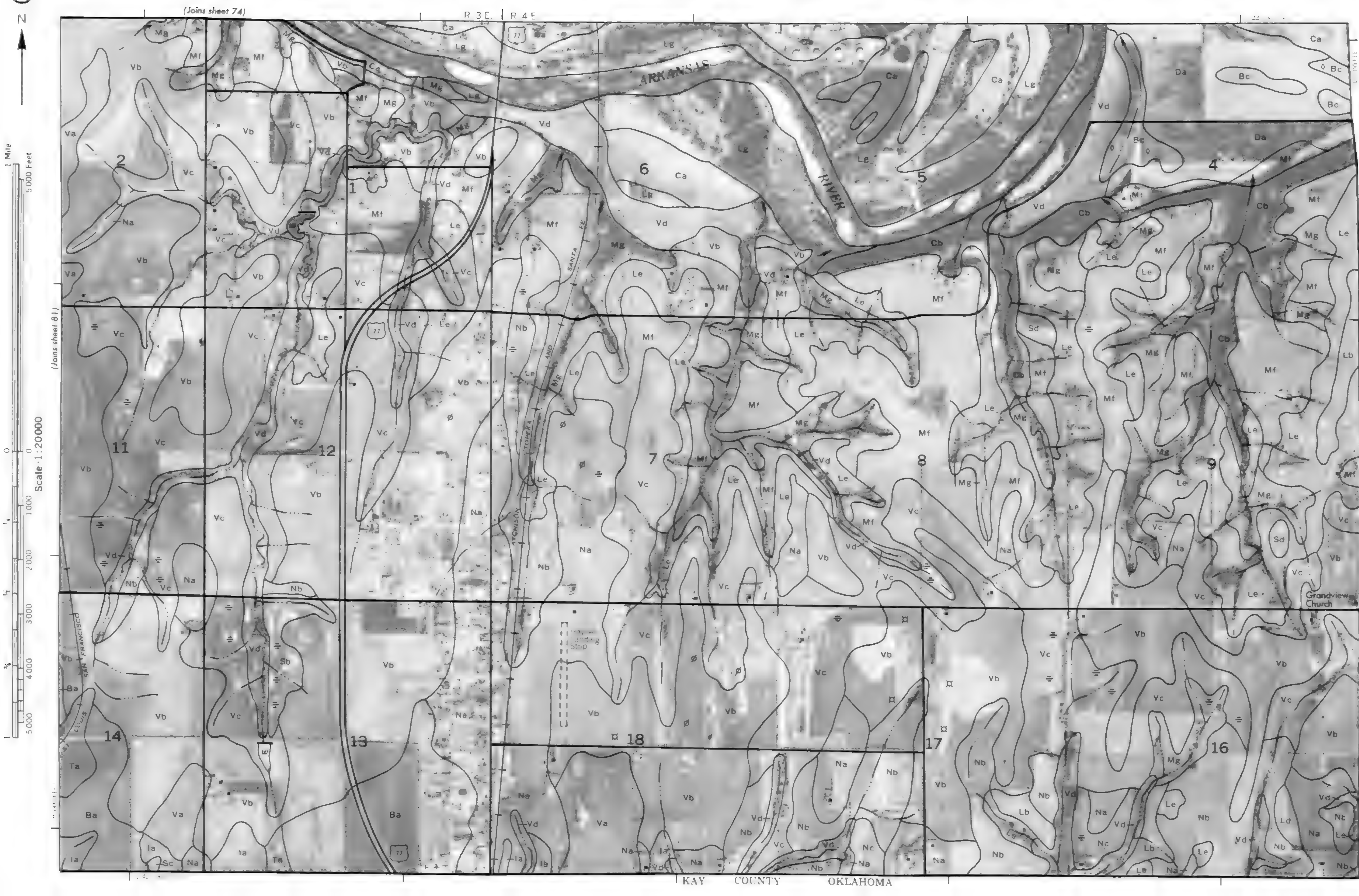
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


(Joins sheet 73)
(Joins sheet 82)
R 3 E
T 35 S
N
Mt Zion Community Church
Cemetery
Spring Creek
Chilocco Creek
ST LOUIS SAN FRANCISCO
SUMNER COUNTY
KAY COUNTY OKLAHOMA
1 Mile
5000 Feet
Scale 1:20000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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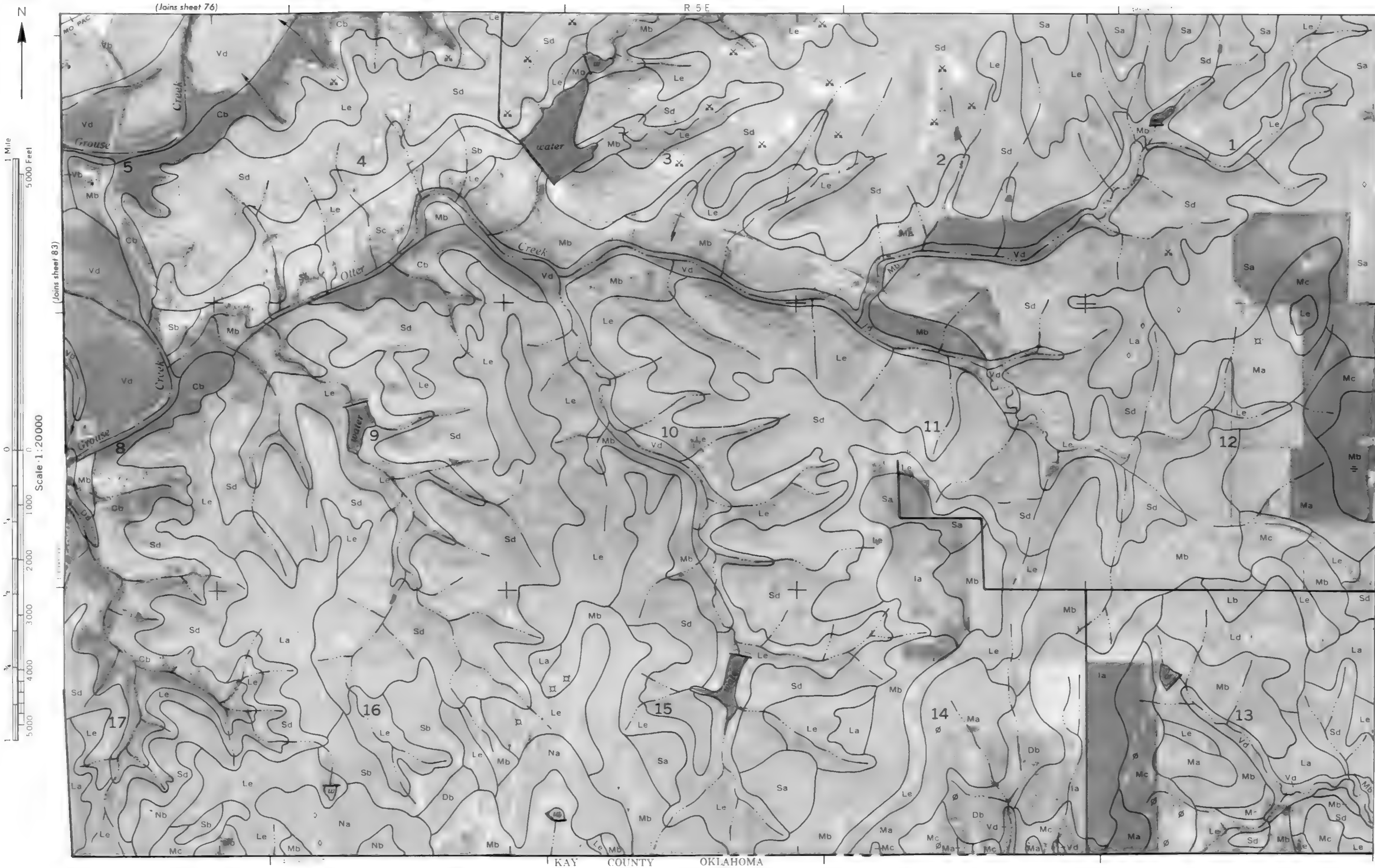
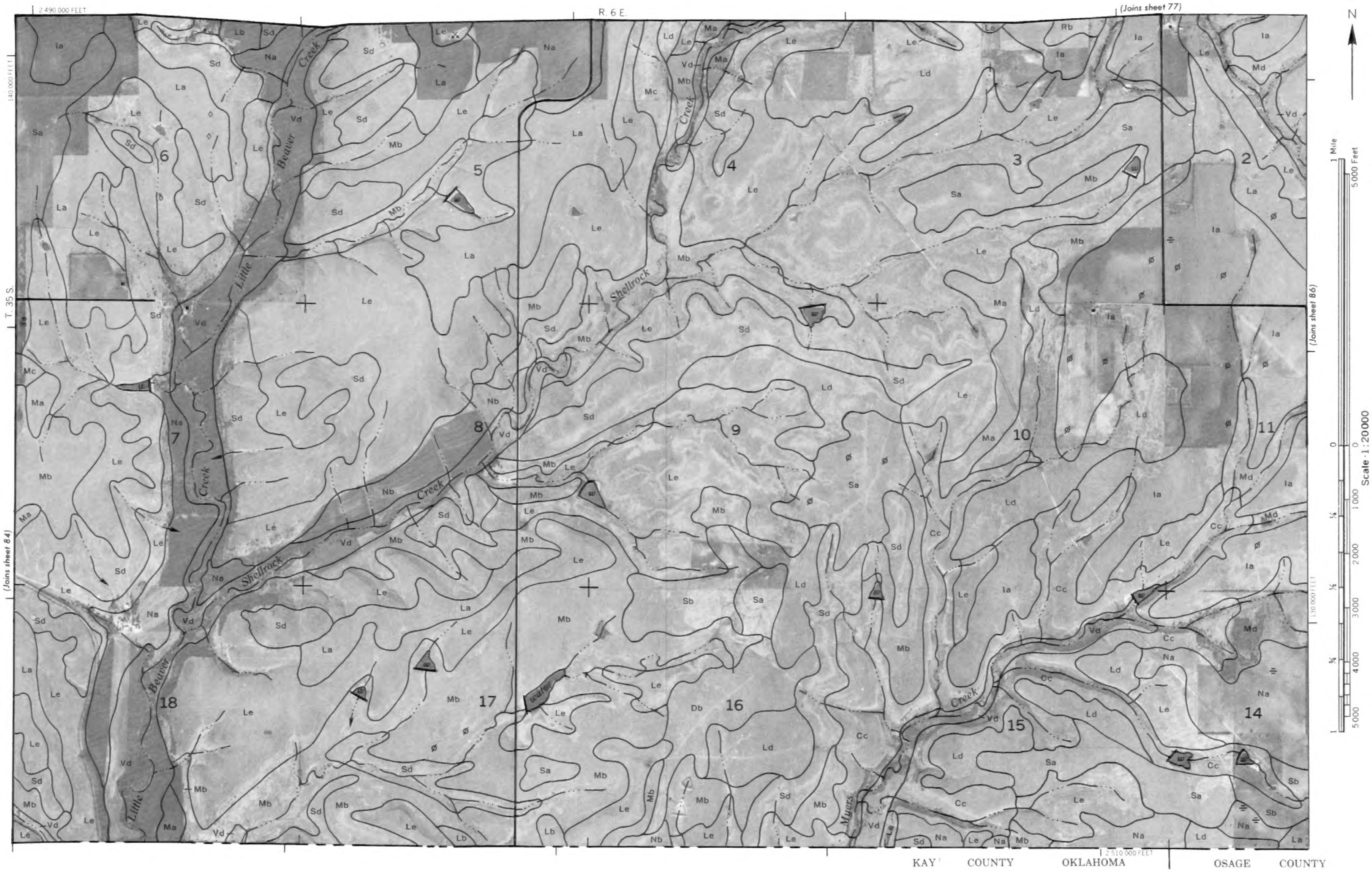
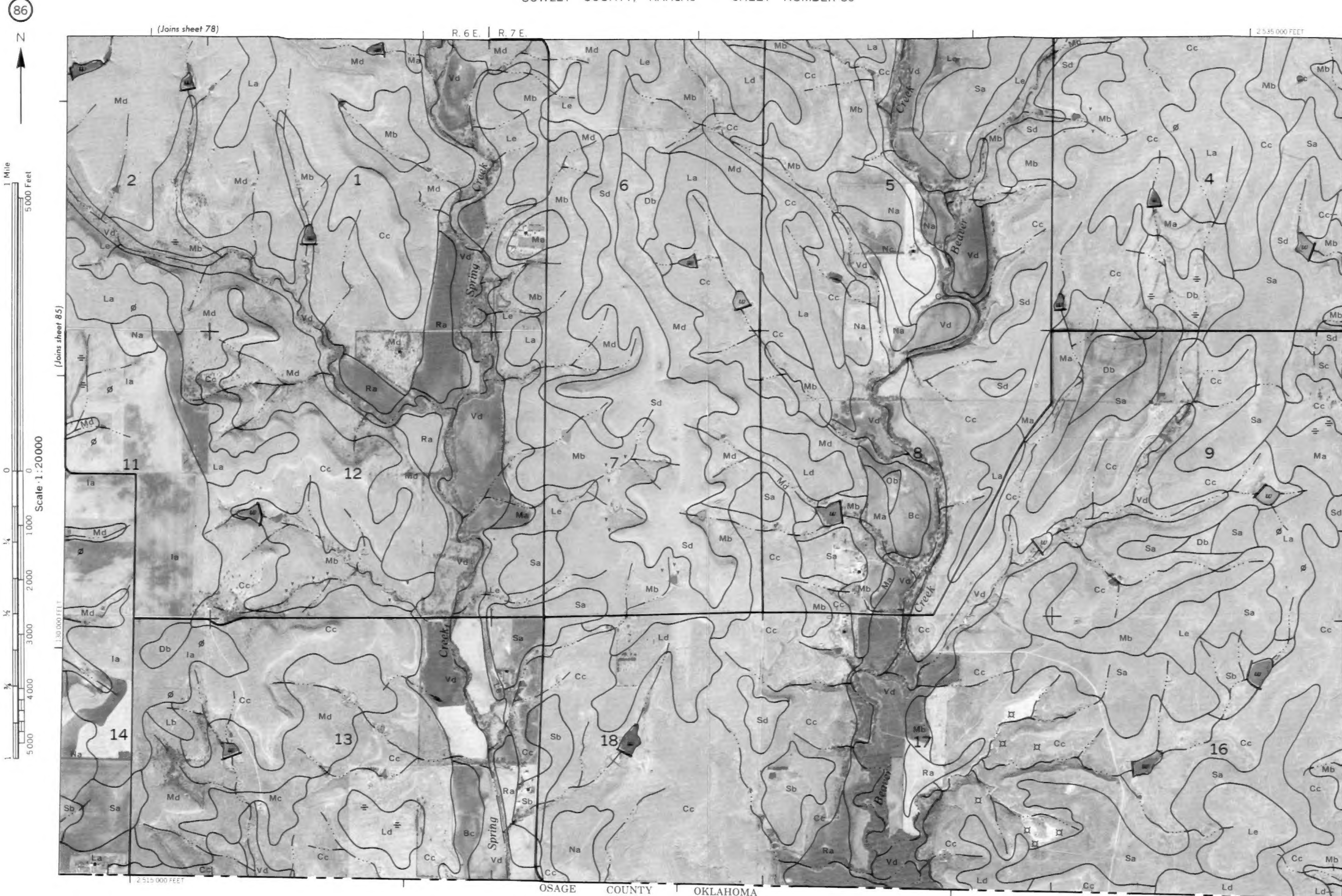
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


(Joins sheet 76)
R 5 E
T 35 S
(Joins sheet 83)
(Joins sheet 85)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
MO PAC
Grouse
Creek
Otter
Creek
water
KAY COUNTY OKLAHOMA

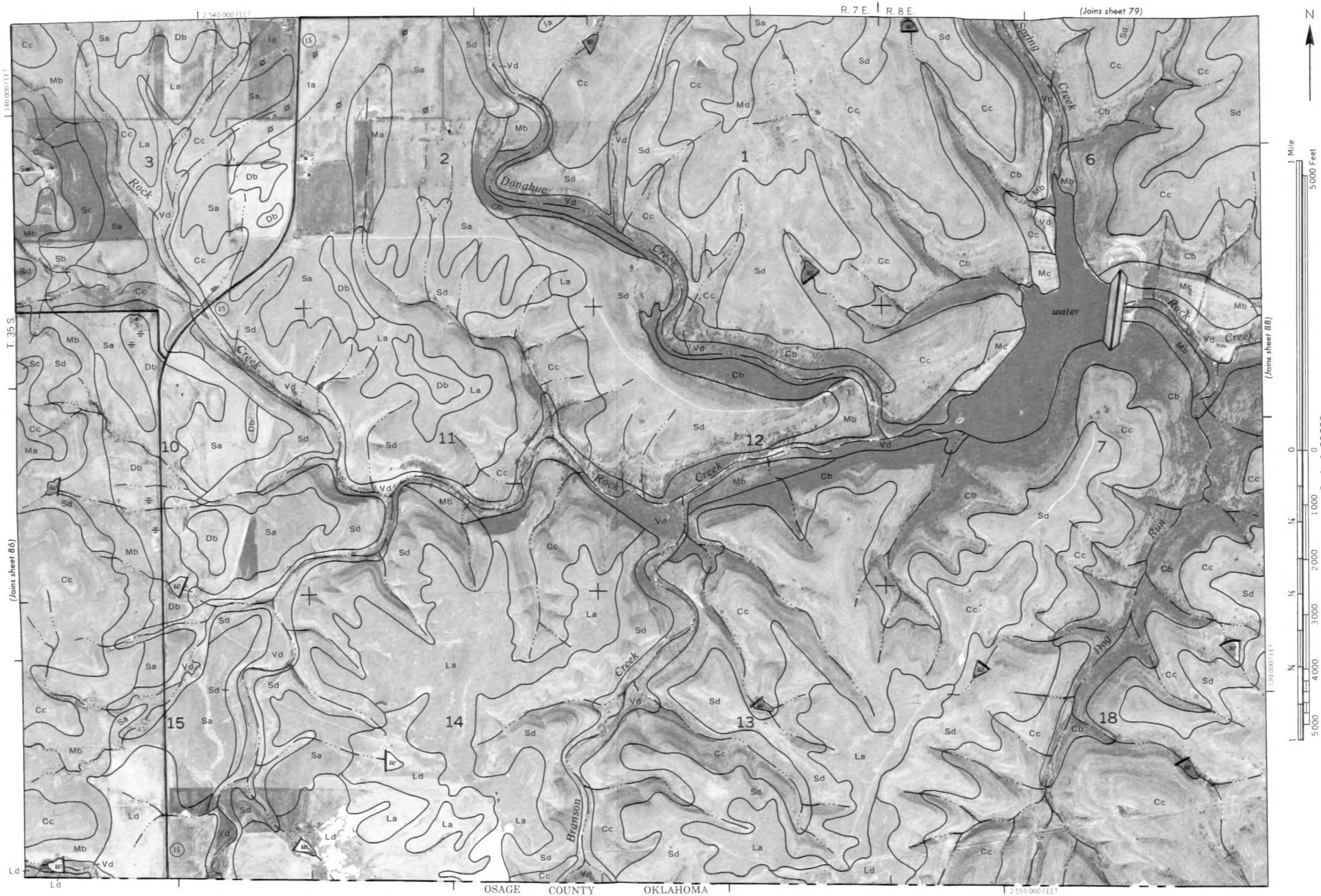


This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

COWLEY COUNTY, KANSAS — SHEET NUMBER 86



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

COWLEY COUNTY, KANSAS — SHEET NUMBER 88

This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.